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Concept Evaluation of the UH-60 Externally Mounted Rescue Hoist

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The concept evaluation of an Externally Mounted Rescue Hoist (EMRH) was performed with the Breeze Eastern EMRH installed on a U.S. Army UH-60 helicopter. A comparative analysis was conducted between the EMRH and the Internally Mounted Rescue Hoist (IMRH) which assessed initial inspection, physical characteristics, installation, and compatibility with the aircraft, performance, and safety. The EMRH showed a significant improvement over the IMRH currently used in U.S. Army MEDEVAC aircraft.

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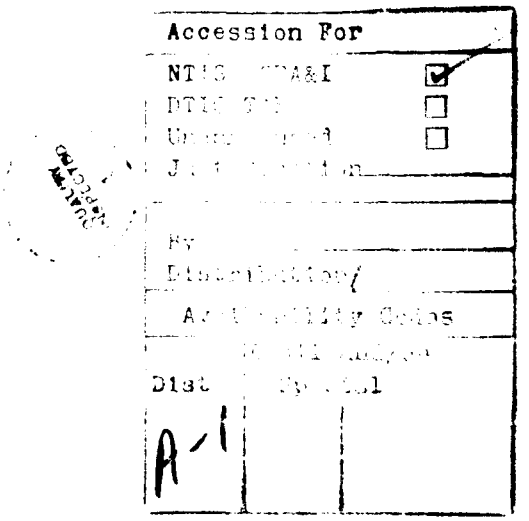

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Section 1. Introduction

There is an urgent need to provide more cabin space in hoist equipped UH-60s for patient care, storage of medical equipment, and use of the medical evacuation (MEDEVAC) carousel litter kit. Because of interference with the internal hoist, maximum litter capacity is limited to three or four litters (depending on type litter kit installed). The candidate Externally Mounted Rescue Hoist (EMRH) should not interfere with either MEDEVAC kit and should allow maximum litter holding capacity to increase from three to four litters (a 33 percent increase) or from four to six litters (a 50 percent increase).

Internal hoist deficiencies were articulated at the Aeromedical Commanders' Conference in 1982 and listed as an action item for Materiel Branch, Directorate of Combat Developments (DCD), Academy of Health Sciences (AHS), and Health Services Command (HSC). A search of existing or proposed technologies was coordinated through the U.S. Army Medical Research and Development Command (USAMRDC) by DCD, AHS, and HSC.

In 1985, a proposal to evaluate the U.S. Navy issue EMRH (currently installed on several U.S. Army special operations UH-60 aircraft), was submitted to The Surgeon General from DCD, AHS, and HSC.

The U.S. Army Medical Materiel Development Activity (USAMMDA) provided initial funding for this program in the third quarter of 1987. The 1989 Battlefield Development Plan Deficiency 72 and 1989 Medical Capability Issues 12 and 27 identified significant deficiencies in casualty treatment and medical evacuation resources which added necessary emphasis to the test program. Actual hoist installation and hoist flight testing was accomplished from September 1989 through February 1990.

1.1 TEST OBJECTIVES

1.1.1 To assess the performance of the EMRH and its compatibility with the UH-60 MEDEVAC aircraft.

1.1.2 To provide comparative assessment data between the internally mounted rescue hoist (IMRH) and EMRH systems.

1.1.3 To determine the degree each hoist meets Army Medical Department Organizational and Operational (O&O) Plan requirements for a high performance rescue hoist.

1.1.4 To determine the operational compatibility of the EMRH with the external stores support system (ESSS) configured for extended range operations.

1.2 TESTING AUTHORITY

1.2.1 USAMRDC directed the U.S. Army Aeromedical Research Laboratory (USAARL) to assess and evaluate the MEDEVAC capabilities of a UH-60 MEDEVAC helicopter equipped with an externally mounted rescue hoist in USAMRDC memorandums dated 24 February 1988 and 26 April 1989 (Appendix A).

1.3 SCOPE

1.3.1 This test was conducted within designated test flight areas in and around Fort Rucker, Alabama, and Fort Benning, Georgia, using resources available to USAARL, and in cooperation with the 498th MEDEVAC Company, Fort Benning, Georgia. The USAARL UH-60, aircraft serial number (ASN) 88-26069, was configured with the EMRH and used as the test aircraft for flight evaluation from July through November 1989.

1.3.2 Several UH-60 aircraft equipped with IMRH systems and the MEDEVAC kit carousel from the 498th MEDEVAC Company, Fort Benning, Georgia, were used for comparative evaluations.

1.3.3 There were 15.4 flight hours logged on the USAARL UH-60 during testing. Flight hours logged on the 498th MEDEVAC UH-60 were not tracked.

1.3.4 Data collected assessed the following: Acceptance inspection, new equipment training, reliability, availability, maintainability, electronic compatibility, human factors, and safety.

1.3.5 Photo documentation was completed, as necessary, throughout the evaluations and is included in this report.

1.3.6 Testing of this system was not considered a major action significantly affecting the quality of the human environment and, therefore, qualified for categorical exclusion from filing an Environmental Impact Statement (A-28), as shown in AR 200-1, Appendix A.

1.3.7 A U.S. Army Aviation Systems Command (AVSCOM) airworthiness release (AWR) dated 9 January 1989 was received prior to installation of the EMRH on the USAARL UH-60A aircraft and is included in this report as Appendix B.

1.4 MATERIEL DESCRIPTION

1.4.1 The EMRH system consists of an externally mounted hoist assembly (Figures 1, 2, and 3), primary control box/control panel (Figure 4), overhead control box (Figure 5), relays, circuit breakers (Figures 6, 7, 8, and 9), and associated electrical wiring. The hoist is electronically controlled by the UH-60 DC electrical system and hydraulically powered by the UH-60 backup hydraulic pump. Its speed is variable from zero to 215 feet per minute (fpm). The pod element (Figure 10) consists of the hoist which is enclosed in a fiberglass fairing located adjacent to the right engine inlet, above the right cabin door. The EMRH pod is supported by a removable tubular support and base covered by a two-piece fiberglass fairing. The support is bolted to a support fitting on the fuselage at station 335.75. The hoist and strut can be swung down as a unit, providing clearance for removal of the right engine inlet fairing without hoist disconnection or removal. The hoist load is limited to a maximum capacity of 600 pounds. The hoist contains 250 feet of cable, of which 240 is usable. The hoist incorporates an electronically activated cartridge, guillotine-type cable cutter, and an automatic cable brake. The first and last 20 feet of the cable are bright orange to warn of end approach. The hoist hook (Figure 11) is attached to the cable end by a ball bearing swivel. The hoist assembly is comprised of a winch, hydraulic drive motor, heat exchanger, fan, and control box.

1.4.2 The aircrewman's pendant provides the primary mode of hoist operation from the cabin (Figure 12). A thumb wheel switch on the pendant, spring loaded to neutral, controls the rescue hoist in either direction. The hoist operational speed is governed from zero to 215 fpm, depending on thumb wheel displacement. The pendant also incorporates a "press to talk" trigger switch which enables the aircrewmember/operator to communicate on the aircraft's internal communication system (ICS). It also includes a cargo hook release switch (nonoperational). The pilot rescue hoist control panel located on the center avionics console enables either pilot to override the aircrewman's pendant and operate the hoist from the cockpit at a set rate of 100 fpm. This box incorporates the master on/off switch for hoist operation, an up/down switch, the cable shear switch for emergency cable jettison, a squib test circuit consisting of a test/norm switch with a test "good" indicator light, and a boom switch (nonoperational). If primary power EMRH is lost for emergency operation, a backup control power switch provides backup electrical power. This switch allows backup control to override a hardover condition caused by preliminary electric power failure or a means to run the hoist in case of a limit switch failure. The switch is located on the overhead hoist control panel in the cargo compartment and operates the hoist at a fixed rate of 85

fpm. It is protected by a safetied switch guard to prevent inadvertent operation in this mode.

Figure 1. Front view UH-60 with EMRH installed.

Figure 2. Three-quarter view UH-60 with EMRH installed.

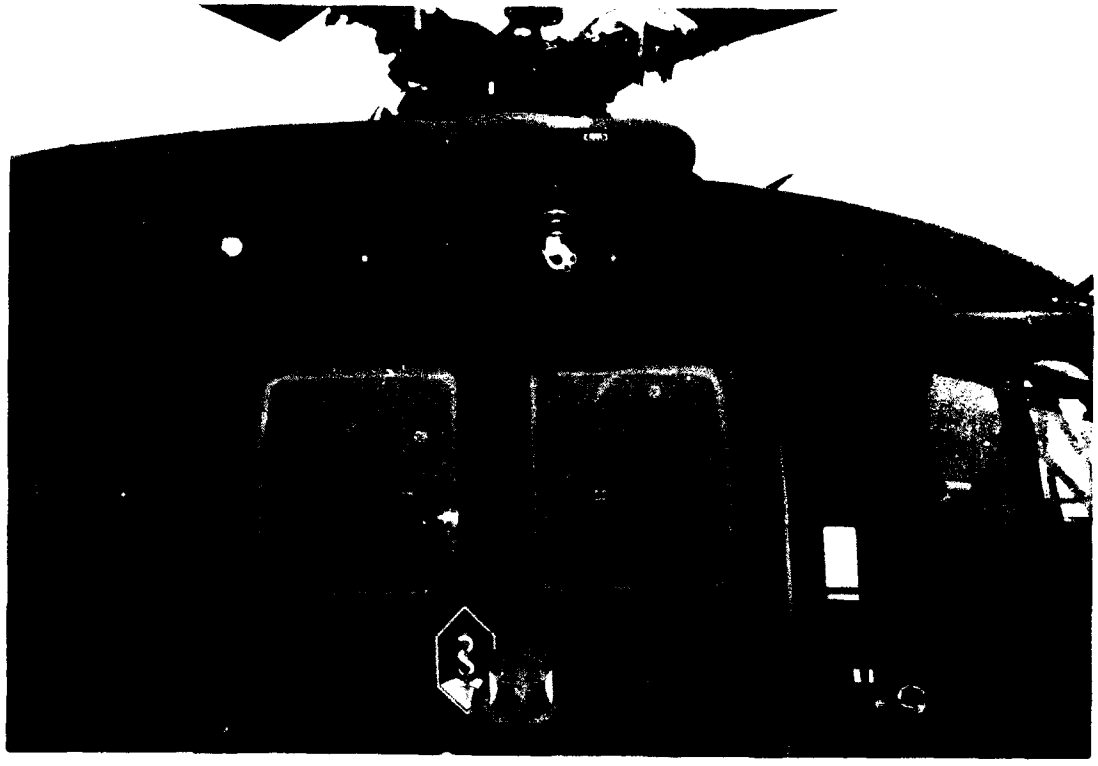

Figure 3. Side view UH-60 with EMRH installed.

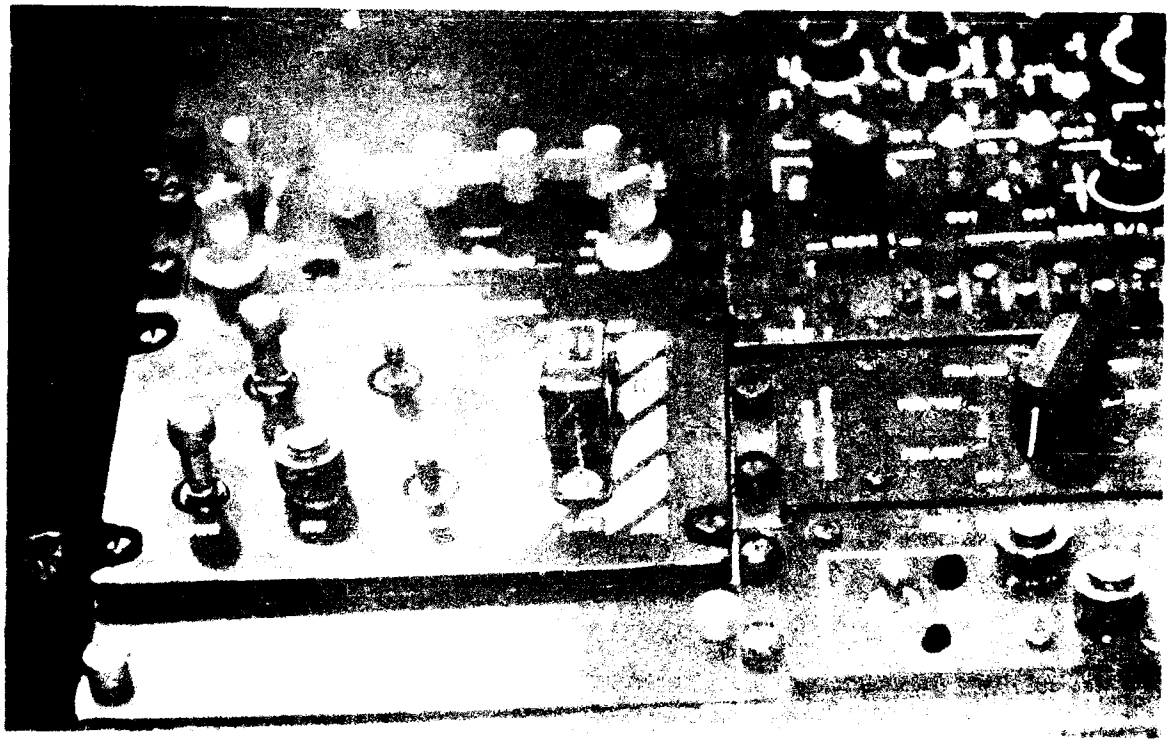

Figure 4. Primary control panel.

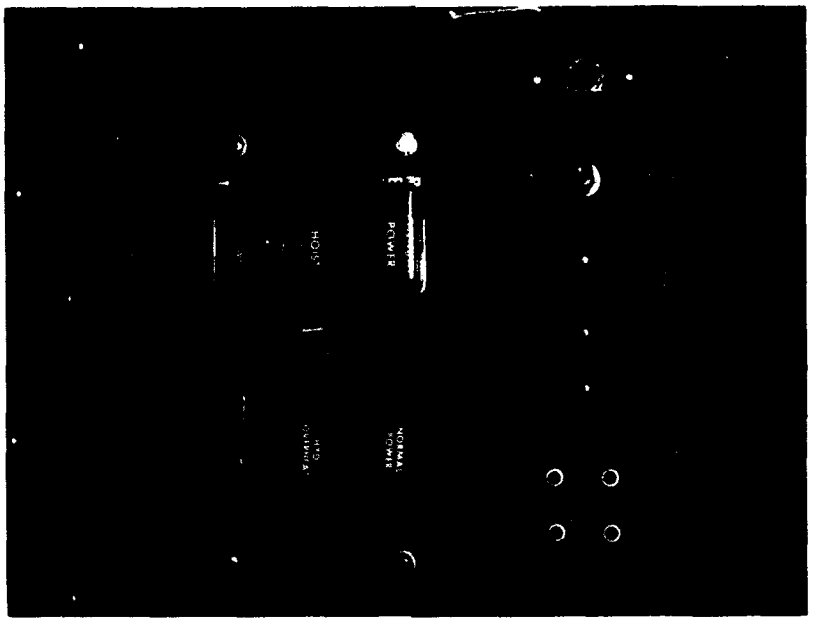

Figure 5. Overhead control panel.

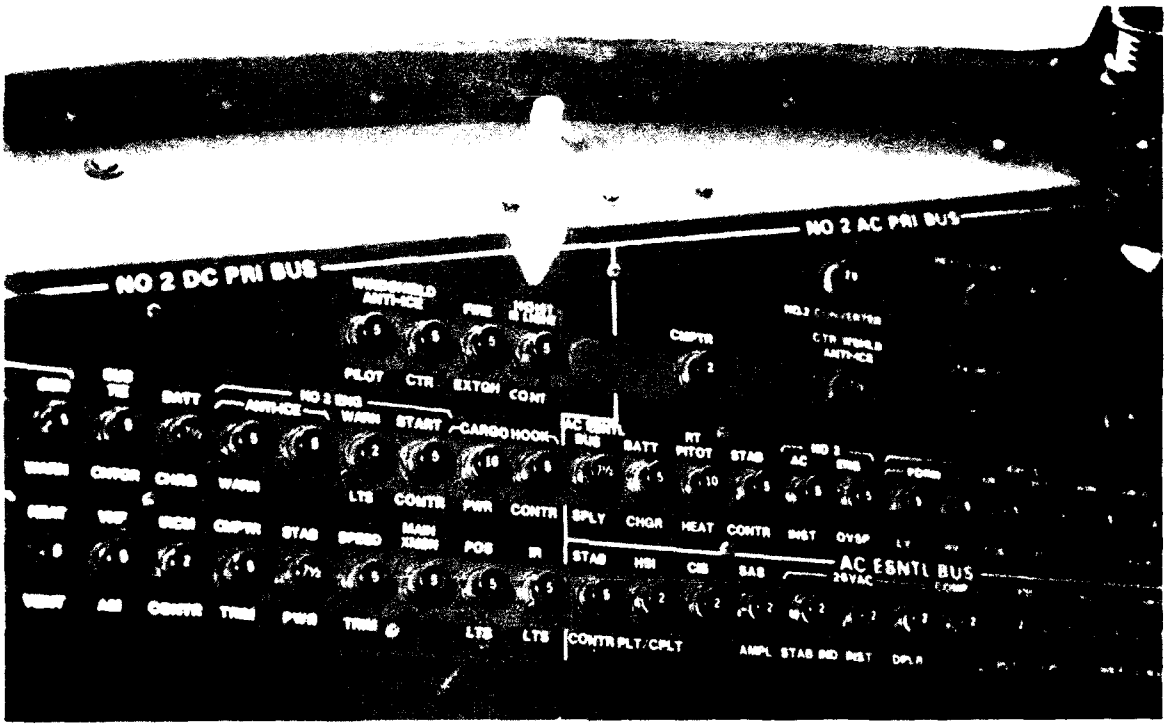

Figure 6. Circuit breaker panel located above and behind pilot's seat (hoist IR light 5-amp circuit breaker).

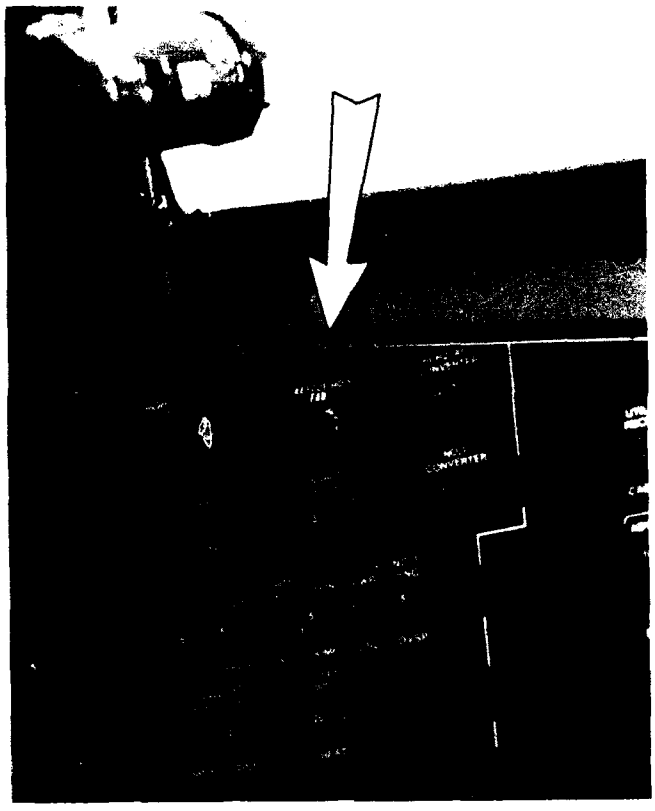

Figure 7. Circuit breaker panel located above and behind copilot's seat (rescue hoist fan 5-amp circuit breaker).

Figure 8. Circuit breaker panel located above and behind co-pilot's seat (hoist IR light 5-amp circuit breaker).

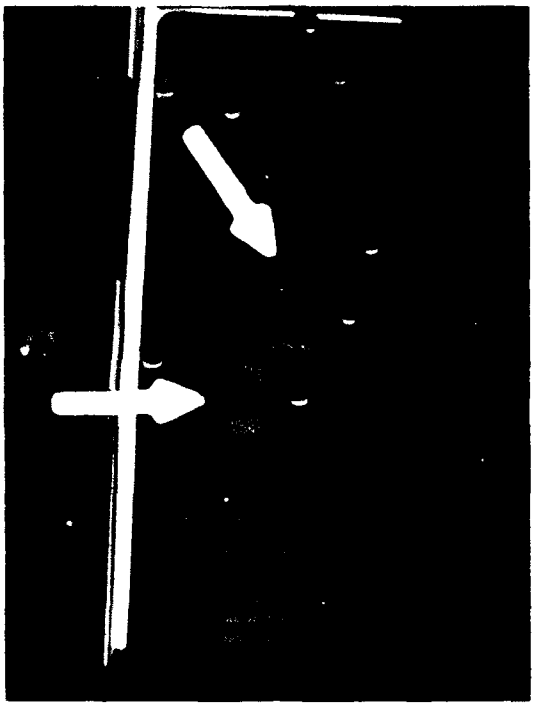

Figure 9. Mission equipment circuit breaker panel located over left gunner/crewmember seat (hoist control 5-amp circuit breaker and emergency hoist control 5-amp circuit breaker).

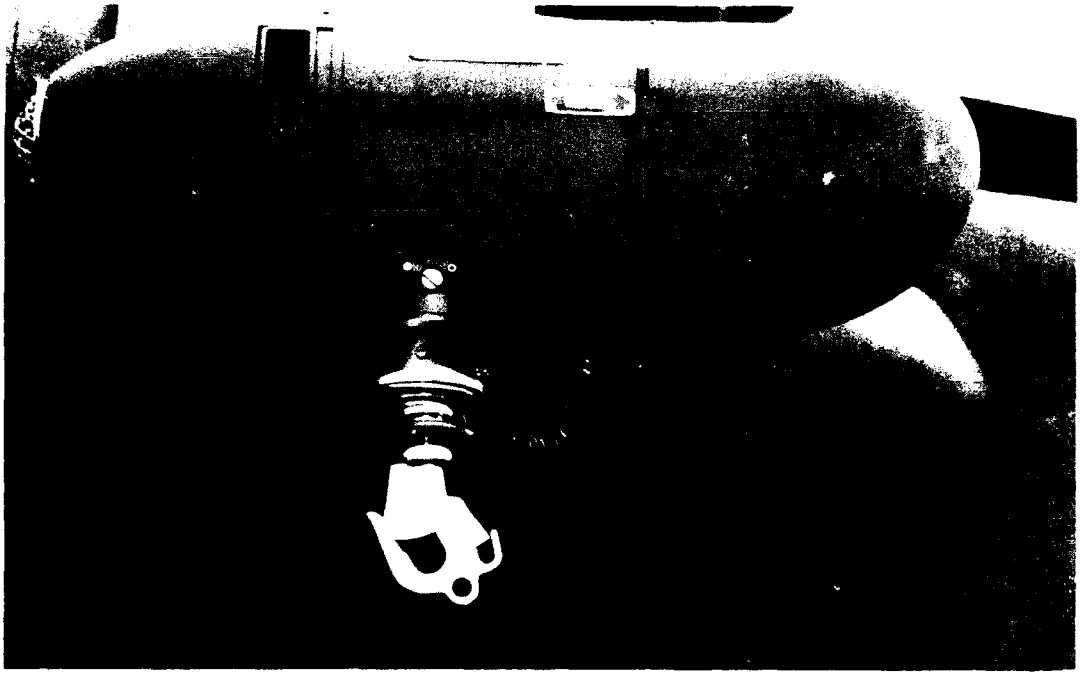

Figure 10. Encased hoist pod assembly.

Figure 11. Candidate EMRH hoist hook.

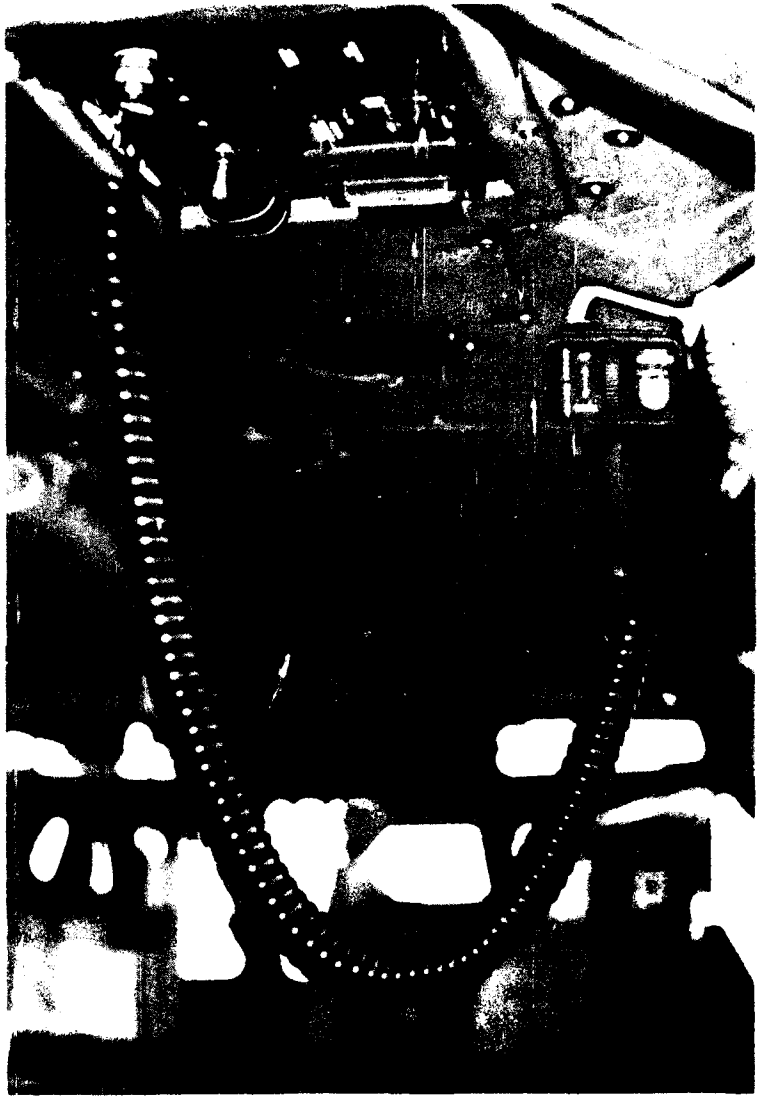

Figure 12. EMRH pendant and overhead control panel.

Section 2. Subtests

2.1 INITIAL INSPECTION

2.1.1 Objective

To determine whether the test items (components of the EMRH system) were complete and ready for test.

2.1.2 Criterion

The EMRH system components would be present and operational prior to acceptance by USAARL.

2.1.3 Data acquisition procedure

2.1.3.1 A visual inspection and inventory of the test items were completed prior to acceptance at Corpus Christi Army Depot (CCAD), Texas. The test items were unpacked and inventoried in accordance with Volume 2, Maintenance, UH-60 Black Hawk Enhancement Program documentation supplied by the program manager, Black Hawk, AVSCOM, and Department of the Navy A1-H60BB-NFM-0001 operator's manual. The contents were compared with the packing list.

2.1.3.2 The major components of the EMRH system were listed and photographed.

2.1.3.3 The test items were inspected visually for any missing or inappropriate cautions and markings.

2.1.3.4 The EMRH was checked by designated personnel from CCAD and two U.S. Army test pilots. All AWR electronic magnetic compatibility (EMC) and electronic magnetic interference (EMI) system validation requirements were completed prior to acceptance.

2.1.4 Results

2.1.4.1 No discrepancies were recorded during the initial inspections and inventory.

2.1.4.2 Photo documentation was completed.

2.1.4.3 Appropriate cautions and markings were present.

2.1.4.4 The AWR EMC and EMI requirements were satisfactorily met prior to acceptance.

2.2 PHYSICAL CHARACTERISTICS

2.2.1 Objective

To determine the physical characteristics of the EMRH in comparison to the IMRH.

2.2.2 Criteria

2.2.2.1 Compare the weights of the EMRH and IMRH. The maximum acceptable weight was established at 174 pounds by the O&O plan for the EMRH. Weight is defined and measured as the difference between airframe weight before and after installation of the total rescue hoist system.

2.2.2.2 Compare UH-60 cargo space availability with the EMRH and IMRH installed. The O&O plan for the EMRH requires "EMRH will not interfere with either MEDEVAC litter kit and will allow maximum litter holding capacity to increase from three to four litters (a 33 percent increase)" in the four-litter carousel configuration, "or from four to six litters (a 50 percent increase)" in the six-litter carousel configuration.

2.2.2.3 Compare the elapsed time indicators of the EMRH and IMRH systems.

2.2.2.4 Compare the fixed EMRH to the IMRH-powered mechanism to assist rotation of the hoist boom and corresponding patient/personnel/other loads into the aircraft cabin.

2.2.2.5 Compare the EMRH to the IMRH color-coded cable ends with 20 feet (2.9 m) of orange painted cable (EMRH) or red painted cable (IMRH) extending from the hook end and 20 feet (2.9 m) of painted cable extending from the drum end. Compare the paint wear and the visual implications of paint wear on the cables of the EMRH and the IMRH.

2.2.2.6 Compare the EMRH to the IMRH for the capability of an emergency or backup system for cable/hoist retrieval which is required by the EMRH O&O plan.

2.2.2.7 Compare the IMRH hoist hook to the EMRH hoist hook which incorporates a positive lock to prevent inadvertent disconnect.

2.2.2.8 Compare the EMRH to the IMRH capability of identifying the length of cable extended during operation (other than the 20 feet color-code at each end of the cable).

2.2.2.9 Compare the EMRH to the IMRH lack of a mechanism to clean and lubricate the cable automatically.

2.2.2.10 Compare the EMRH blue/green overhead panel warning light to the IMRH red warning light located on the pendant to indicate a high temperature condition of the hydraulic fluid in the hoist.

2.2.2.11 Compare the EMRH blue/green power light on the overhead control box to the IMRH blue light on the pendant which is provided to indicate power has been applied to the hoist.

2.2.2.12 Compare the usable EMRH cable length to the cable length of 250 feet (76.2 m) which is required on the EMRH O&O plan and present on the IMRH.

2.2.3 Data acquisition procedure

2.2.3.1 The total EMRH system weight was measured physically. Data was provided by the DA Form 365C annual review and inventory completed 29 September 1989 on the USAARL UH-60 test aircraft, which listed the following components and weights:

Fixed provisions external rescue hoist: 28.4 pounds.
Rescue hoist control: 2.0 pounds.
Rescue hoist cabin control: 3.0 pounds.
Rescue hoist light control, pendant and mount: 3.5 pounds.
Rescue hoist: 92 pounds.
Hoist wiring: 8 pounds.

The IMRH hoist weight data were derived from the UH-60 aircraft operator's manual, TM-55-1520-237-10, chapter 6.

2.2.3.2 The EMRH and IMRH were installed with the UH-60 MEDEVAC litter carousel in the "fly" position and set up in the four-litter, followed by the six-litter operational configurations. Comparative space available assessments were accomplished by the project officer and seven aircrewmembers/flight medics. Hoist operation compatibility with the MEDEVAC kit and litter carousel is addressed in Performance paragraph 2.4.3.

2.2.3.3 The IMRH possesses an elapsed time indicator that records in tenths of hours time of actual hoist operation. It is located on the control panel assembly attached to the structure support assembly of the IMRH and is visually accessible when the boom is in the stowed position. The EMRH incorporates an elapsed time indicator located under the forward cowling that records hours of operation. This indicator is visually accessible only when the forward cowling is removed. Four contract maintenance personnel questioned on elapsed time indicators said the indicator on the IMRH was their only data recording mechanism to document time based inspection requirements and failures on the IMRH system. These personnel stated they did not have objection

to the indicator being placed under the forward cowling because the EMRH indicator is referenced only after a failure and the cowling must be removed for troubleshooting. The maintenance personnel questioned stated an elapsed time indicator should remain as a required component.

2.2.3.4 The EMRH does not possess a powered or assist mechanism to rotate the boom and associated loads into the aircraft cabin for the purpose of load placement. Crewmember test participants were questioned on the powered boom assist mechanism and the possible benefits of such a capability. [It was stated that such an assist is desired for IMRH operations only.] The EMRH hoist boom does not rotate or flex, nor is it required to do so, during operation.

2.2.3.5 The EMRH and IMRH cables were inspected for identification or markings to indicate 20 feet of cable had been played out and that 20 feet of usable cable remained on the reel. The painted cable ends of both systems were measured with a flexible steel tape. The distance measured from the tip of the cable at the hook assembly, extending up the cable to the end of the orange paint, was measured and listed as the "hook end." Red hook end markings on the IMRH were measured at 19 feet 7 inches, 19 feet 9¼ inches, and 19 feet 4 inches. The orange hook end marking on the EMRH was measured at 21 feet 3 inches. At full cable extension, the distance measured from the tip of the paint up the cable to the exit point of the cable guide on the hoist pod, was measured and listed as the "drum end." Drum end markings on the IMRH were measured at 19 feet 10 3/4 inches, 19 feet 4 inches and 18 feet 10½ inches. The drum end markings on the EMRH was measured at 14 feet 10½ inches. The paint on both systems was assessed against military specification requirements. The cable paint was checked for visual identification capability during both day and night operations by the project officer and the project NCO.

2.2.3.6 The EMRH emergency backup system for cable/hoist retrieval was described in the Materiel description subtest, paragraph 1.4.2.

2.2.3.7 EMRH hook

a. The EMRH and IMRH hooks were inspected visually by the project officer and three crewmembers to check for positive lock mechanisms.

b. Aircrewmembers noted the lack of a pit pin keeper to secure the hook lock flange in the closed position on the EMRH hook. This pit pin keeper was present on the seven IMRH hooks surveyed, and is a required safety feature on the IMRH.

c. A second auxiliary hook is located on the back of the primary hook of the IMRH (Figure 11). The second hook can accommodate carabiners used with the aircrew survival armor recovery vest insert and packets (SARVIP).

2.2.3.8 The EMRH and IMRH systems were assessed by the project officer, project NCO, and four aircrewmembers on the capability of a mechanism for identifying cable playout status. The EMRH does not possess an identification mechanism or markings to indicate the amount of cable that has been played out other than the 20 feet orange paint markings at the ends of the cable. Seven aircrewmember participants were asked to assess the utility of the IMRH pendant light when compared to the concept of a digital readout or audio indicator/alarm. The IMRH pendant light is activated when approximately 10 feet or less is played out of the cable drum and, again, when approximately 10 feet or less is remaining on the cable drum (full extension). It is commonly referred to as the "10 foot out/10 foot in" light. Aircrewmembers consider this pendant feature highly desirable at a high hover, during diminished light conditions, and during night vision goggle (NVG) operations where depth perception is a problem.

2.2.3.9 The EMRH and IMRH systems do not possess a mechanism to clean and lubricate the cable automatically. Seven aircrewmembers and six maintenance personnel were interviewed on the need for this capability.

2.2.3.10 The IMRH pendant overtemp warning light was compared to the EMRH overhead panel warning light.

a. The EMRH incorporates a blue/green high temperature warning light located on the cabin overhead control panel. All eight aircrewmember participants said this light was necessary, but must be placed on the pendant. The IMRH pendant warning light is located on the pendant. When the aircrewmember is performing a hoist operation, he is looking at the patient, monitoring and controlling the litter movement, and monitoring and directing the pilots on aircraft position. The aircrewmember cannot look above and behind to monitor a possible overtemp condition. His attention is focused totally outside the aircraft.

b. EMRH engineers were questioned on the reason for placing the warning light on the overhead console. They said the light is a backup device and the hoist should not overheat during mission scenarios involving MEDEVAC operations. The following test was conducted to address this issue:

(1) The maximum secured (seat belts or strapped in) patient load in a UH-60 with six-litter configuration is seven

patients. This consists of six litter patients and one ambulatory patient seated between the crew chief and medic. An absolute maximum load is the addition of the rear left and right cabin seats which interfere with the carousel configuration but bring the total possible patient load to nine, which includes the three seated ambulatory patients. Ten hoist iterations were selected to add a safety factor to the test.

(2) A clothed 95th percentile male articulated mannequin weighing 238 pounds was used in conjunction with the forest penetrator as a worst case scenario for lift weight.

(3) Normal off-loading and securing of the patient may take up to 2 minutes in actual hoist operations. The 10 hoists were performed with a 30-second delay on each iteration at the aircraft to simulate but minimize patient off-loading cycles.

(4) All 10 hoist iterations were performed at the maximum cable extension of 250 feet.

(5) All 10 hoist iterations were performed at maximum possible speed. However, hoist speed was slowed several times due to load oscillation during lift and during the last 10 feet (approximate) as the load was raised near the aircraft.

(6) The outside air temperature (OAT) recorded during the hoist operations ranged from 25 to 27 degrees Centigrade.

(7) Total time elapsed during hoist operations was 40 minutes.

(8) The hydraulic "HYD OVERHEAT" warning light did not illuminate at any time during this test. Light operation was confirmed prior to and after this hoist operation test.

(9) Although hydraulic overtemp is not considered to be a concern with the EMRH operation, there still is the possibility of internal component mechanical or aircraft subsystem failure. Due to this concern, it is recommended the hydraulic overtemp warning light be moved to the pendant.

2.2.3.11 Crewmembers questioned said the EMRH power indication light is located on the overhead console. The light is referenced by the hoist operator when initial power is applied, but the thumb wheel is used to confirm subsequent operations. Power off confirmation is referenced at the end of hoist operations.

2.2.3.12 Cable length of the EMRH system was listed in the manufacturer's data as 250 feet with 240 feet usable. The EMRH cable was measured with a steel tape at full extension from the exit point of the cable guide to the upper connection ring of the

hook at 248 feet 3 inches, and again at full extension measured from the floor surface of the cargo compartment at 242 feet 11 inches. No compatibility or operational problems were encountered with the 250-foot cable length on the cable drum or within the hoist pod during testing operations. The 250-foot cable length of the IMRH system was obtained from both the UH-60 and UH-1 operations manual specifications and was not physically measured.

2.2.4 Results

2.2.4.1 The EMRH weight of 136.9 pounds is an improvement over the 180 pounds of the IMRH and less than the maximum acceptable weight of 174 pounds in the EMRH O&O Plan.

2.2.4.2 Criteria met: The physical dimensions and mounting location of the IMRH caused cabin obstructions which block litter placement. The IMRH limited the carousel litter holding capacity to three litters in the four-litter configuration, and four litters in the six-litter configuration. Approximately one-fifth of the cabin area is occupied by the IMRH. The EMRH allowed full four-litter and six-litter carousel utility, and left an unobstructed cabin area for use as necessary.

2.2.4.3 The elapsed time indicator of the EMRH was found to be satisfactory and compared equally to the IMRH indicator. DCD and AHS requested a window be cut into the cowling of the EMRH to allow visual access during daily inspection of mission equipment due to a reported high incidence of failure of the timing mechanism on the IMRH.

2.2.4.4 IMRH operations would benefit from a powered mechanism to rotate the hoist boom. Due to the fixed mounting of the hoist arm, the overhead hoist arm location and the cable manipulation capability, the EMRH has no requirement for boom rotation or a powered boom assist.

2.2.4.5 The cable markings on both the EMRH and IMRH systems deviated from the required 20 feet marking from either end. The greatest error detected was the EMRH drum end cable marking, which was short by 5 feet 1½ inches. Cable marking is an essential and easily correctable quality control function. The paint used on both the EMRH and IMRH for cable marking does wear off the cables as a function of use. However, the paint that remains in the strands and cable grooves was found to be adequate for both day and night identification purposes. The orange and red paints used on the two systems do meet military specification requirements and do not interfere with NVG operations.

2.2.4.6 The EMRH has incorporated an emergency backup system for both extension and retrieval operations. The IMRH does not possess an electronic emergency backup system for cable retrieval.

The backup system is viewed as a necessary contingency for combat operations.

2.2.4.7 The EMRH and the IMRH hooks were found to possess positive lock (latch) mechanisms which are spring loaded to the closed position. The hoist hook of the IMRH was preferred over the hoist hook of the candidate EMRH. Safety issues relating to the design of the EMRH hook are addressed in the Safety subtest paragraph 2.5.3.4.

2.2.4.8 The EMRH pendant should incorporate a 10 foot in/10 foot out warning light similar to the one included on the IMRH pendant. Crewmember participants questioned on the utility of the IMRH pendant light said the pendant light is a feature that would be desired over a digital readout or audio indicator. Safety implications relating to the pendant light also are discussed in the Safety subtest, paragraph 2.5.3.4.

2.2.4.9 Automatic cable cleaning and lubricating provisions are not considered necessary and are not included in the EMRH or IMRH systems.

2.2.4.10 Hydraulic temperature warning lights are included on both systems. The light on the IMRH is located on the pendant. The light on the EMRH is located overhead, but should be moved to the pendant.

2.2.4.11 The EMRH power indication light is considered adequate in its overhead location. The IMRH power indication light is considered adequate in its present position on the pendant.

2.2.4.12 Criteria not met: The EMRH measured cable length of 248 feet 3 inches was found to be adequate when compared to the documented IMRH cable length of 250 feet, but did not meet the EMRH O&O plan requirement of 250 feet. Cable length discrepancies are an easily correctable quality control function.

2.3 INSTALLATION AND COMPATIBILITY

2.3.1 Objective

To determine installation requirements and aircraft compatibility of the EMRH in comparison to the IMRH.

2.3.2 Criteria

2.3.2.1 Compare the EMRH to the IMRH installation/removal operations and times involved using two maintenance personnel with standard aviation mechanics tool set and current UH-60 ground support equipment (GSE).

2.3.2.2 Compare the EMRH to the IMRH which uses onboard power, without the need of auxiliary power required for other essential functions during the mission. Power drain on the aircraft should not adversely affect operation of any existing aircraft systems.

2.3.2.3 The EMRH control system must interface with controls and circuits already present in UH-60 aircraft with the MEDEVAC kit installed. Compare the EMRH to the IMRH mode of operation which is controlled by the crew chief or medic, with an additional set of overriding controls provided for operation by the pilot or copilot.

2.3.2.4 Compare the EMRH to the IMRH which remains within the fore, aft, and lateral center-of-gravity (c.g.) limits of the aircraft when operated at a full load (600 pounds) and maximum cable acceleration.

2.3.2.5 Compare the EMRH to the IMRH mounting compatibility with the basic ESSS and the ESSS extended range (fuel) configuration installed.

2.3.2.6 Compare the EMRH to the IMRH hoist hook compatibility with the forest penetrator, the Stokes litter, the semirigid poleless litter, the SKEDCO™ litter, and SARVIP connection/ hookup points.

2.3.3 Data acquisition procedure

2.3.3.1 Installation and removal

a. The required airframe structural reinforcement was performed by Sikorsky Aircraft during initial aircraft production. The EMRH was installed in the test aircraft by maintenance personnel at CCAD. The initial installation included an airframe modification requiring depot installation. No Army personnel were qualified or trained to remove or replace the EMRH.

b. Contract maintenance personnel at Cairns Army Airfield, Fort Rucker, Alabama, estimated EMRH hoist pod removal or replacement as a 0.5-hour aviation unit maintenance (AVUM) level maintenance action. The approximate weight of the hoist pod assembly is 92 pounds, which necessitated the commitment of two maintenance personnel. No special tools are required. The EMRH system requires a permanent airframe modification. As such, removal and replacement, wear and tear issues pertaining to the system and the aircraft are not applicable.

c. The IMRH can be installed or removed by two experienced crewmembers in less than 5 minutes. UH-1 crews have no problem with these actions, but the UH-60 crews cite occasional damage to

cabin floor, roof, and the hoist connection points. Damage to the IMRH during frequent temporary storage also is a concern. Seven crewmembers and five pilots assessed the EMRH and stated the permanent external hoist does not interfere with any known present or proposed cabin or mission configuration.

2.3.3.2 The test aircraft was operated at 100 percent rotor on the ground with flat pitch in the rotor system. Power was applied to the hoist, and the medic on board operated the hoist. The test pilots monitored aircraft systems and gauges for fluctuation or abnormal indications. Gauge fluctuation, abnormal indications, and decreased performance were monitored by the crew during hoist operations, power on, and power off iterations during this test. This system's monitoring continued during the entire flight test program. Communications and avionics compatibility will be addressed in the Safety subtest paragraph 2.5.3.6.

2.3.3.3 The EMRH system control box was checked for compatibility with the UH-60 aircraft during installation at CCAD. Seven different aircrewmembers operated the hoist from the pendant while in the ground mode. The pilot control box was operated by five different aviators from both the pilot's and copilot's station, to verify override capability in the stop, up, and down modes. The backup control power switch in the cabin overhead was activated by an aircrewmember and the hoist was operated from this panel after a simulated electrical failure of the primary hoist controls.

2.3.3.4 Weight and balance calculations were completed using the procedures described in chapter 6 of TM 55-1520-237-10, the UH-60 operator's manual. Pertinent data for the test UH-60 were derived from the aircraft weighing record (DD Form 365-2), the basic weight and balance record (DD Form 365-3), and from chapter 6 of the operator's manual. The total IMRH system weight was presented earlier in the "Physical characteristics" paragraph 2.2.3.1. These data were used in determining the weight and balance of the various helicopter/hoist/load conditions. Longitudinal c.g. calculations were performed for the hoist/load combination with the hoist installed and including crewmembers and equipment required for operation of the hoist and MEDEVAC missions. In one condition, the hoist arm load was computed at the 600-pound maximum load and increased by a factor of 1.34 to 802 pounds. The 1.34 increase was derived from previous hoist load/acceleration measurement testing (St. Cyr et al., 1978) to account for the momentary peak acceleration of the IMRH. DA Forms 365-4 were completed to reflect the actual multiple test flight configurations. A comparative assessment of these configurations is provided in Table 1. Upon completion of initial satisfactory weight and balance computations, actual flight

Table 1.

Test configuration weight and balance.

Configu-ration No.	Takeoff/ landing condition	* Fuel	* Litter patients	* Hoist Load	* Gross weight	c.g.	Appendix reference
1	Takeoff	800	0	0	13,650	356.0"	C-1
2	Landing	300	0	0	13,150	353.5"	C-1
3	Takeoff	2,350	0	0	15,200	362.6"	C-2
4	Landing	588	0	0	13,438	355.0"	C-2
5	Takeoff	800	795	600	15,045	354.5"	C-3
6	Landing	300	795	600	14,545	352.1"	C-3
7	Takeoff	800	0	600	14,250	355.1"	C-4
8	Landing	300	0	600	13,450	352.7"	C-4
9	Takeoff	800	0	802	14,452	354.8"	C-5
10	Landing	300	0	802	13,652	352.4"	C-5

* Weight in pounds

All c.g. measurements fall within fore and aft c.g. limitations.

All configurations include: Aircraft basic weight (hoist and MEDEVAC kit installed), pilot, copilot, 200-lb crew member at station 270.8, and 200-lb crew member at station 387.2.

condition weight and balance sheets were calculated prior to flight and placed in the appropriate log books and records. Copies of the completed weight and balance forms are presented in Appendix C.

2.3.3.5 The EMRH system installation and ESSS compatibility assessments are as follows:

a. Airframe modifications required for the ESSS were assessed by the engineers at the U.S. Army Aviation Development Test Activity (USAAVNDTA), Fort Rucker, Alabama, against airframe modification requirements of the EMRH and the IMRH systems.

b. The ESSS pylon with the 230-gallon ESSS fuel tank was installed during the test for measurement assessment. A station reference point was selected to measure distance between the cabin floor and the ESSS tank at the point where hoist operations are conducted. The station reference point is measured at the location along the aircraft's longitudinal axis (seen as a vertical plane cutting through the width of the airframe) where the EMRH cable is extended down from the drum (EMRH) or arm (IMRH), between the floor and ESSS fuel tank. Floor measurements were taken from the outer edge of the cabin floor at the station reference point. Tank measurements were taken from the widest point of the tank at the station reference point. The widest point of the tank was slightly above the cabin floor, so a plumb line was used (suspended from the inboard radius of the tank) to measure the horizontal clearance between the floor and tank.

c. The 230-gallon ESSS tank configuration was mounted on the outboard side of the pylon bracket according to established maintenance and configuration standards. The minimum horizontal clearance between the outer edge of the cabin floor and the inboard diameter of this tank was measured at 26 9/16 inches. Engineering drawings show the minimum distance between the floor and the 230-gallon tank is 24 inches (measured at a point forward of the hoist cable station reference point). Cable center to floor was measured horizontally at 16¼ inches and cable center to tank was measured horizontally at 10 7/16 inches. Hoist/ESSS compatibility assessments were conducted on the ground with one participant (Figures 13 and 14) and two participants (Figure 15) using the forest penetrator. Hoist compatibility operational assessments were conducted with one participant wearing the SARVIP (Figures 16, 17, and 18). Litter operations were assessed with the use of the SKEDCO™ litter, semirigid poleless litter, and the Stokes litter in the vertical and horizontal lift positions. Litter contact with the 230-gallon tank was assessed. The 450-gallon ESSS tanks were not available for the test. Tank and airframe location approximations were provided from specification data supplied by engineering personnel at the USAAVNDTA. The 450-gallon tank configuration is mounted on the inboard side

of the ESSS pylon bracket. The minimum clearance between the inboard diameter of this tank and the outer edge of the cabin floor was calculated at 14 inches. EMRH and IMRH hoist operations with the forest penetrator and SARVIP were assessed for compatibility with the 450-gallon ESSS tank configuration by constructing a 14-inch wide and 3 feet long box. A 95th percentile articulated male mannequin wearing the SARVIP was raised and lowered through the box with contact due to the breadth of the chest area. Litter operations with the 450-gallon ESSS tank configuration were assessed with the use of the SKEDCO™ litter, semirigid poleless litter, and the Stokes litter in the vertical and horizontal lift positions.

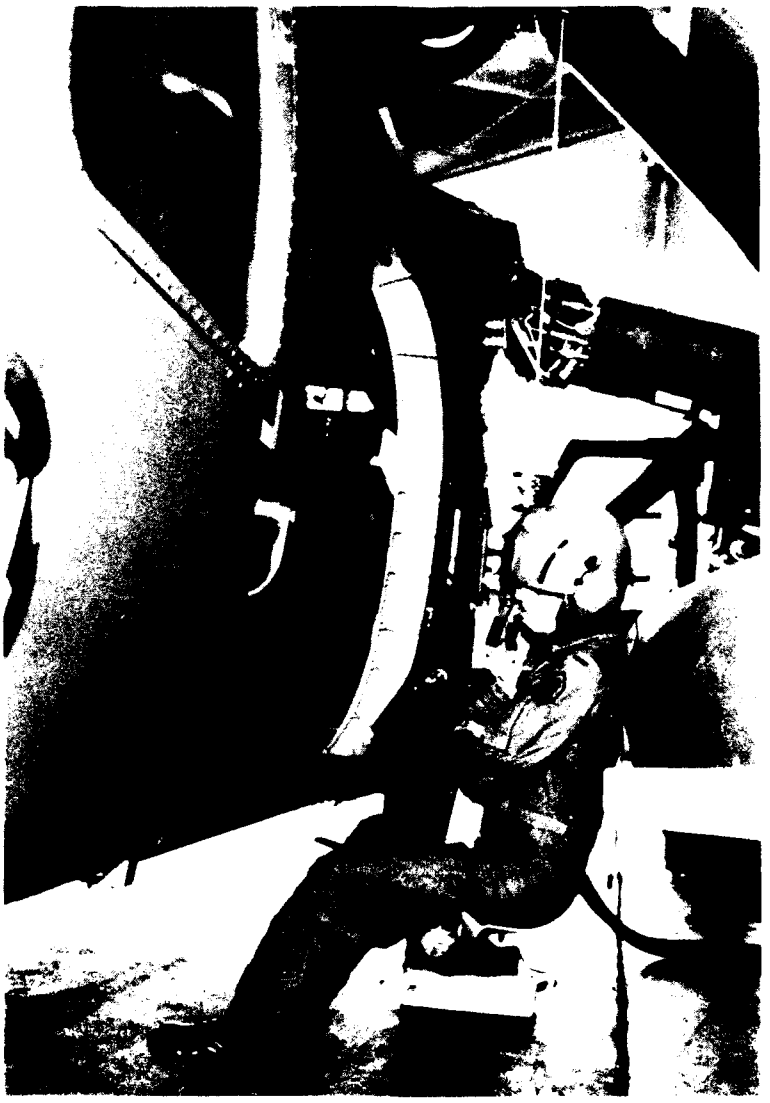

Figure 13. Forest penetrator lift, one man, below cabin floor, 250-gallon ESSS.

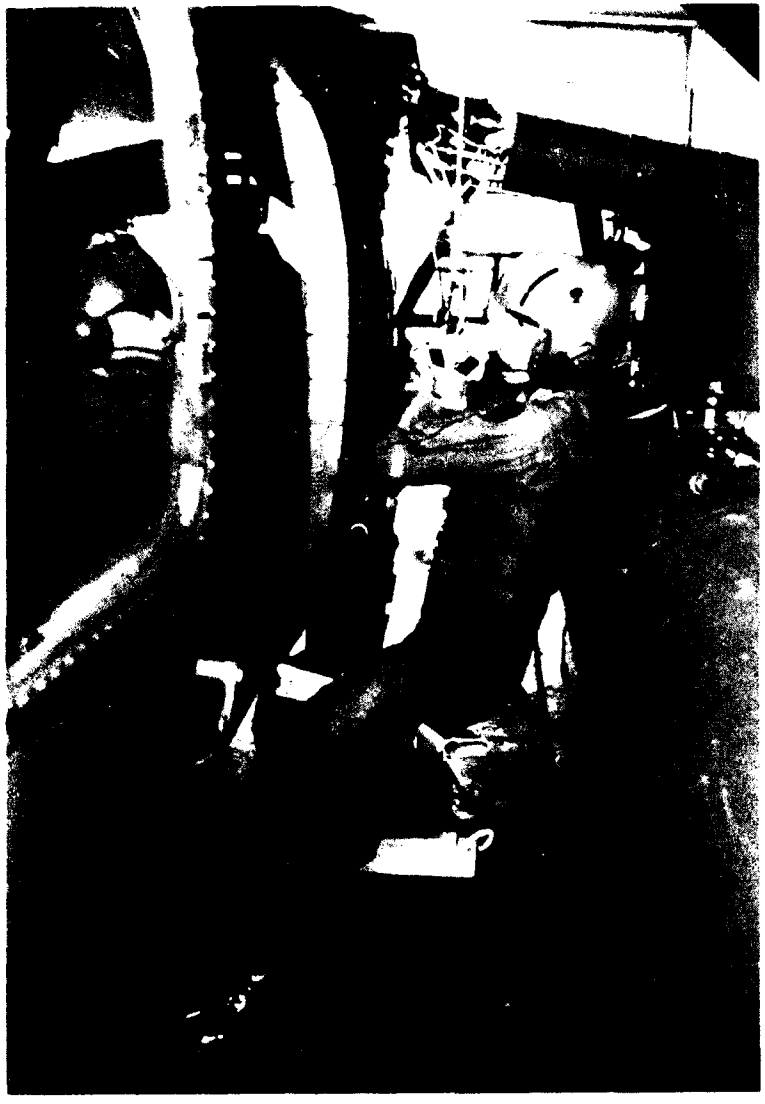

Figure 14. Forest penetrator lift, one man, above cabin floor, 250-gallon ESSS.

Figure 15. Forest penetrator lift, two man, cabin floor level, 250-gallon ESSS.

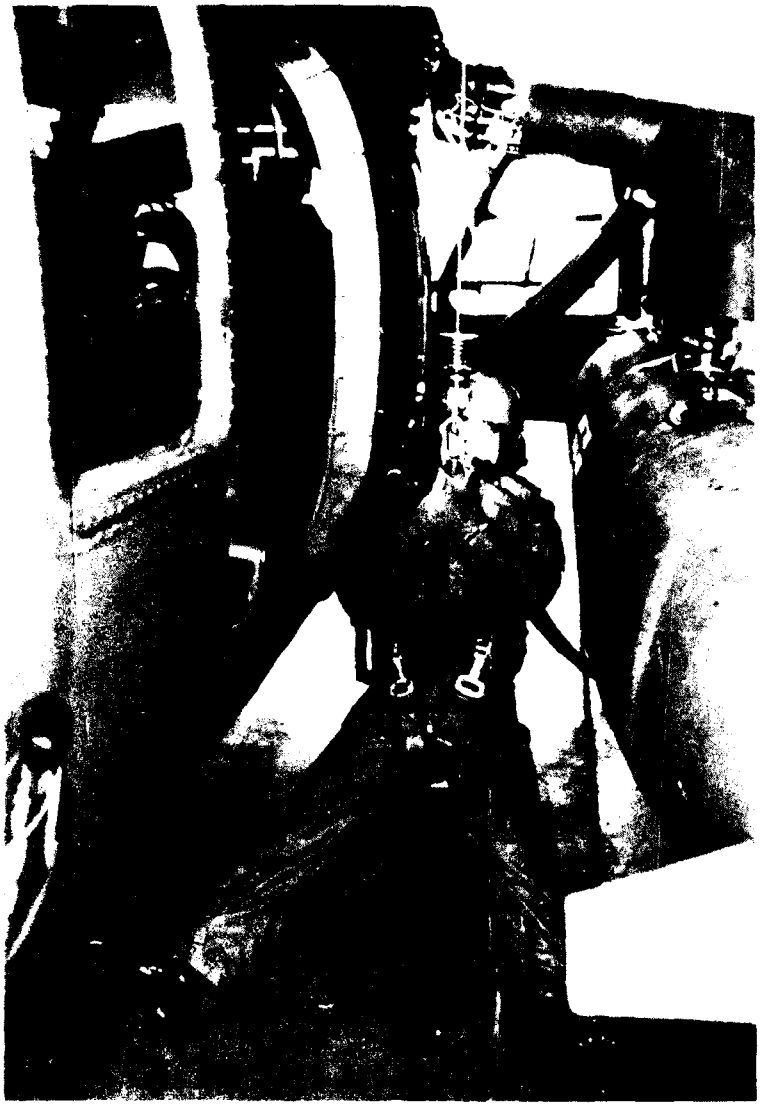

Figure 16. SARVIP lift, one man, perpendicular to airframe axis.

Figure 17. SARVIP lift, one man, parallel to airframe axis.

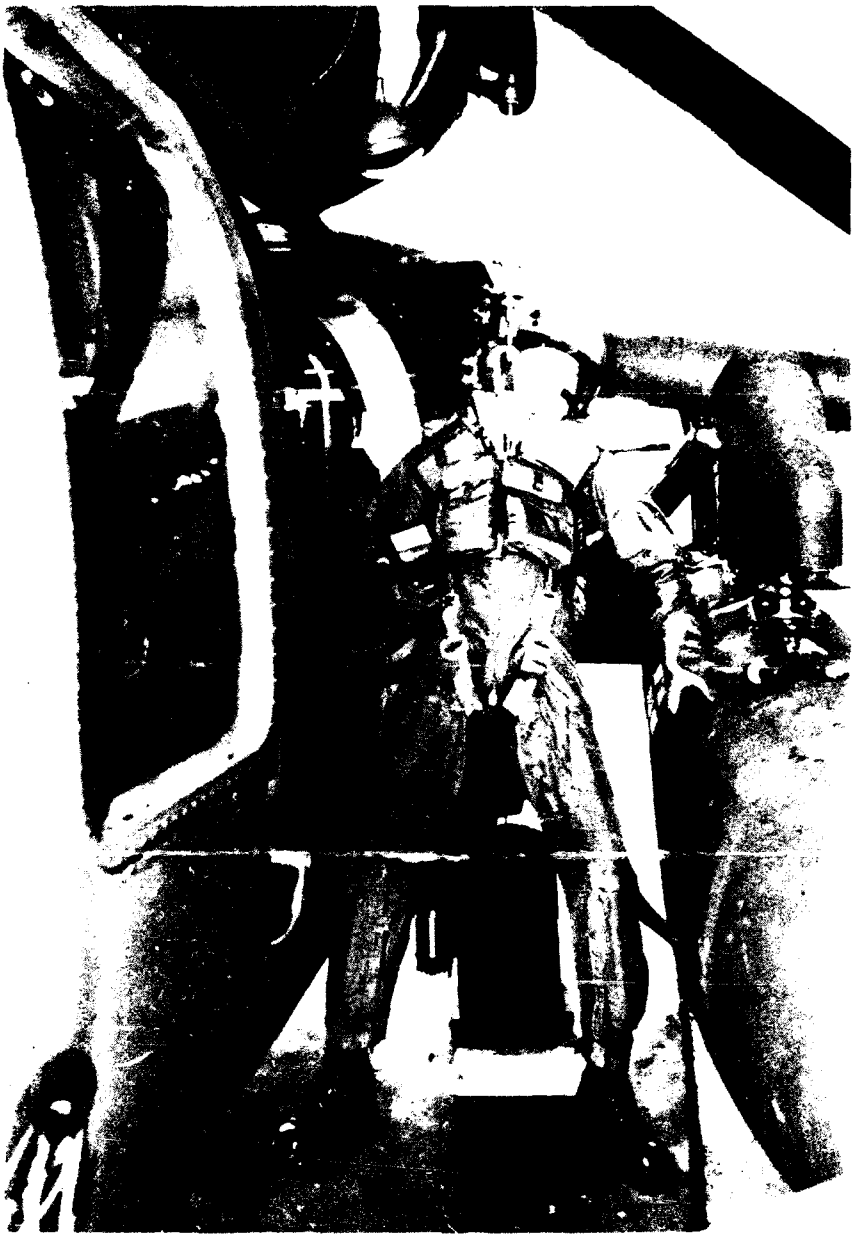

Figure 18. SARVIP lift, one man, perpendicular to airframe axis.

2.3.3.6 The EMRH and IMRH hooks were assessed by the project officer and four crew members for hook-up compatibility and security with the forest penetrator, the Stokes litter, the SARVIP, and the SKEDCO™ litter connection points as well as four different types of carabiners ("D" rings) which included the carabiner hooked to the SARVIP. The suspension cables for the Stokes litters were found to be of varying lengths. Standardization of cable length for litter/hoist operations is necessary

to definitively assess litter/litter pan compatibility with the EMRH. "Standard" cables 4 feet 2 3/4 inches in length with looped ends were fabricated by the maintenance contractor, U.S. Army Aviation Center and School, Fort Rucker, Alabama. Each cable was routed through one of the four side connection points on the Stokes litter. Each cable then was "halved" and both looped ends were secured with its own carabiner. All four carabiners then were connected to a central carabiner which served as the hookup point. The horizontal lift/descent straps provided with the SKEDCO™ litter were connected to a central carabiner and used as designed throughout testing on that item.

2.3.4 Results

2.3.4.1 The installation or removal time for the EMRH pod is not applicable due to the EMRH design as a permanent structure. The EMRH was removed for this test in approximately 30 minutes. The installation or removal time for the IMRH is less than 5 minutes. The overhead external permanent installation of the EMRH is preferred over the internal hoist even when considering the flexibility offered by the ability to move the IMRH from one aircraft to another. This is due to the penalties of installation/removal times required by the IMRH and cabin floor, roof, or hoist damage incurred during these iterations. Additional damage to the IMRH is not uncommon during frequent periods of temporary storage. Storage damage of the EMRH is not a factor due to the permanent mounting of the system.

2.3.4.2 The EMRH does not use helicopter auxiliary power which is required for other essential functions during the mission. EMRH operation did not adversely affect operation of any existing aircraft systems or cause instrument panel gauge fluctuation at any time during the flight test program.

2.3.4.3 The EMRH control system is compatible with the existing controls and circuits of the UH-60 with MEDEVAC kit installed. Systems operation was satisfactory from the crewmembers' pendant and the control box on the center console. Pilot override capability was verified. The emergency backup control (not included on the IMRH) capability was verified.

2.3.4.4 The EMRH aircraft, hoist, and load configurations calculated for this test were within the prescribed aircraft weight and balance and c.g. limitations.

2.3.4.5 EMRH and IMRH compatibility assessments with the ESSS basic and the ESSS extended range (fuel) systems are:

a. Airframe modifications required for the EMRH or IMRH and the ESSS were found to be compatible.

b. There was no difference in hoist load compatibility between the EMRH and IMRH when interfaced with the ESSS systems. ESSS and UH-60 airframe interface with various hoist loads are compiled in Table 2 and detailed findings follow.

Table 2.

Hoist load/ESSS compatibility.

	230 gal ESSS	450 gal ESSS
Stokes litter (vertical)	No	No
Stokes litter (horizontal)	No	No
Semirigid poleless litter (vertical)	Yes	Possible *
Semirigid poleless litter (horizontal)	Yes**	No
SKEDCO™ litter (vertical)	Yes	Possible *
SKEDCO™ litter (horizontal)	Yes**	No
Forest penetrator (1 person)	Yes**	No
Forest penetrator (2 or 3 person)	Yes**	No
SARVIP (1 person)	Yes	Yes
SARVIP (2 or 3 person)	Yes	No

* Possible with caution and training, depending on patient size.

** Yes, but specific training will be required prior to operations.

(1) (230-gallon ESSS tank compatibility) Forest penetrator operations are possible, but care must be taken due to possible seat contact with the fuel tank during lift. This concern is discussed in the SAFETY subtest paragraph 2.5.3.5.

(2) (230-gallon ESSS tank compatibility) Although only one prototype SARVIP was available for testing, we are satisfied simultaneous extraction of up to three crewmembers wearing the SARVIP could be accomplished without tank/cabin floor compatibility problems.

(3) (230-gallon ESSS tank compatibility) Litter operations are possible with the use of the SKEDCO™ litter or semirigid poleless litter in the vertical or horizontal lift positions. During horizontal lifts, litter contact with the 230-gallon tank is highly probable, but acceptable if reasonable caution is used.

(4) (230-gallon ESSS tank compatibility) The Stokes litter in the horizontal lift position is not compatible with the 230-gallon tank due the minimum tank/floor clearance of 24 inches and the width of the rigid metal Stokes litter frame of 23 3/4 inches. Stokes litter operations can be conducted with the horizontal litter in the vertical position, but are not advised. Again, this is due to the inadequate tank/floor clearance and the manhandling required to secure the litter in the cabin area or on the litter carousel during hoist operations.

(5) (450-gallon ESSS tank compatibility) EMRH or IMRH operations using the forest penetrator are not compatible with the 450-gallon ESSS tank configuration due to inadequate horizontal tank/floor clearance.

(6) (450-gallon ESSS tank compatibility) Hoist hook operations with patients (one patient per lift) wearing the SARVIP vest are compatible with the 450-gallon tank. Multiple patient lifts (more than one per lift) are not compatible due to the inadequate horizontal tank/floor clearance of 14 inches.

(7) (450-gallon ESSS tank compatibility) Hoist operations using the semirigid poleless and SKEDCO™ litters in the vertical position may be possible, exercising extreme caution and only after structured training has been completed. This possibility is dependent on the breadth and width of the patient's torso.

(8) (450-gallon ESSS tank compatibility) Hoist operations using the semirigid and SKEDCO™ litters in the horizontal position and Stokes litter (horizontal or vertical position) are not possible with the 450-gallon tank due to the inadequate horizontal tank/floor clearance of 14 inches.

2.3.4.6 EMRH and IMRH hoist hooks were found to be compatible with intended support equipment and connecting points. The auxiliary hook on the EMRH will accommodate two carabiners, but the safety latch provided cannot close (Figure 19). Lateral forces or torque will allow the second carabiner to rotate out of the hook and be released. This issue will be addressed in the Safety subtest paragraph 2.5.3.4.

Figure 19. EMRH accessory hook with two carabiners (safety latch open).

2.4 PERFORMANCE

2.4.1 Objective

To assess the operational performance of the test hoist system in comparison to the IMRH.

2.4.2 Criteria

2.4.2.1 Compare the EMRH to the IMRH operational capability for hoist/litter access, litter loading, and litter unloading into the cabin/litter carousel with the forest penetrator, the semi-rigid poleless litter, the SKEDCO™ litter, and the Stokes litter.

2.4.2.2 Compare the EMRH to the IMRH operational compatibility with both four- and six-litter carousel configured in the load, 45-degree, and fly positions.

2.4.2.3 Compare the EMRH to the IMRH operation of a hoist override on the pilot's control panel.

2.4.2.4 Compare the operation of the graduated speed control on the EMRH to the graduated speed control on the IMRH.

2.4.2.5 Compare the operation of the emergency cable cut procedures of the EMRH to the IMRH.

2.4.2.6 Compare the EMRH to the IMRH operations day and night with a red warning and yellow 10 foot in/10 foot out light on the pendant.

2.4.2.7 Compare the EMRH hook to the IMRH hook which provides free rotation with an applied load of 600 pounds (272 kg), and is easy to operate.

2.4.3 Data acquisition procedure

2.4.3.1 The EMRH and IMRH were operated during aircraft ground run and assessed for basic operational compatibility with the forest penetrator, the semirigid poleless litter, the SKEDCO™ litter, the Stokes litter, and the SARVIP. The systems' combinations were further assessed for ease of operation and hoist/litter compatibility during litter loading, and unloading into the cargo compartment and onto the center litter pan position of the litter carousel in the six-man "fly" configuration. A detailed assessment of EMRH and IMRH litter carousel operations is completed in paragraph 2.4.3.2. Three subjects weighing 223 pounds, 210 pounds, and 193 pounds provided the three-patient forest penetrator load. Seven crewmembers knowledgeable in the operation of the EMRH and the IMRH operated both systems and made comparative subjective assessments of each. In subsequent flight

testing, seven crewmembers operated both systems using the forest penetrator, and then the SKEDCO™ litter. The patient load during this test phase was a clothed 95th percentile male articulated mannequin weighing 238 pounds. Comparative subjective assessments were completed by the crewmembers during each configuration combination.

2.4.3.2 The EMRH and IMRH systems were operated and assessed for compatibility with the four-litter and six-litter carousel configurations (Figures 20 and 21). Four pairs of crewmembers (one medic and one crew chief) knowledgeable in the operation of both the EMRH and the IMRH operated both systems during this test phase. Due to the excessive number of hoist iterations required to assess total carousel configuration capability, the following test parameters were established:

a. The Stokes litter was the single hoist load used.

b. The litter was lifted in the horizontal position only.

c. The standard simulated patient load was a 95th percentile articulated male mannequin.

d. Each hoist operation cycle started with the litter on the ground and slack in the hoist cable.

e. All litters were loaded on the litter pan head first.

f. Substantial "manhandling" of the Stokes litter into position on the carousel litter pans was considered acceptable to simulate a "worst case" emergency scenario.

g. Only hoist assisted litter load maneuvering in the cabin area with the hoist cable remaining connected was considered acceptable.

h. After initial litter loading, movement of a loaded litter within the cabin area or on the litter pan without hoist cable security was considered unacceptable.

i. The carousel litter pans were set up for the four-litter and six-litter configurations.

j. No ambulatory patient loads were considered for load assessments.

k. The carousel and hoist load capability was assessed with the carousel placed in the:

(1) Fly position (fore and aft) only.

Figure 20. Litter carousel fly position, six-man configuration, Stokes litter in horizontal position, loading head first.

Figure 21. Litter carousel 45° position, six-man configuration, Stokes litter in horizontal position, loading head first.

(2) 45-degree position only.

(3) 45-degree position (load) then moved to the fly position (finish loading).

(4) Load position (90 degree) only.

(5) Load position (load) then moved to the fly position (finish loading).

With the above parameters for test, each pair of crewmembers performed 60 iterations of operating the hoist through a full cycle which included attempting to place the hoisted litter load on the appropriate selected litter pan for a total of 240 hoist iterations per crewmember, per type hoist. This does not include multiple attempts at loading or practicing loading and positioning crewmembers in the cabin area. Crewmember fatigue and heat stress were a concern during testing and planned for. Mandatory "drinks" were established, along with rest periods which increased in frequency as each crewmember team progressed through the loading and unloading scenarios. All tests were performed with the aircraft on the ground to ensure safety of the crewmember participants.

2.4.3.3 The EMRH and IMRH override systems operations were assessed from the pilot station by four qualified and current pilots, from the copilot position by five qualified and current pilots, and from the cabin area by four crewmember participants.

2.4.3.4 The operation of the pendant graduated speed control on the EMRH system was compared to the pendant graduated speed control of the IMRH system by nine crewmembers knowledgeable in the operation of both systems. The speed control was exercised during extension and lift operations from minimum to maximum speed in varying degrees of onset. The systems were operated both on the ground and at high hover which included a minimum of one full (250-foot extension) cable cycle by each crewmember. The pendant was operated additionally on the ground by crewmembers wearing the standard summer flying gloves, butyl rubber chemical protective gloves over flyer's gloves, and the cold weather mittens over the flyer's gloves. The standard summer flyer's gloves or the leather work gloves (shell, black) were worn by crewmembers during actual flight testing. Comparative subjective assessments were made, with emphasis placed on benefits and concerns relating to the operation of each system.

2.4.3.5 A "hands on" exercise and assessment of the EMRH emergency cable cut procedure was performed and compared to the IMRH cable cut procedure. Actual cable cutting was not performed. Five qualified and current UH-60 MEDEVAC pilots performed the assessments from both the pilot and copilot

stations. Three MEDEVAC aircrewmembers performed the assessments from the cabin area. Comparative subjective assessments were made on both systems.

2.4.3.6 Operational effectiveness of the red warning and yellow 10 foot in/10 foot out lights on the IMRH pendant was assessed and compared to the EMRH which has no indicator lights on the pendant. Nine crewmembers assessed the lights during day operations. Five crewmembers assessed the lights during night operations of NVG and non-NVG hoist operations. Operations were conducted at 50 feet AGL, 100 feet AGL, and 200 feel AGL using the aircraft landing light and infrared fuselage light.

2.4.3.7 The EMRH hook performance was assessed as follows:

a. Free hoist hook rotation with the required maximum 600-pound applied load was assessed by using the forest penetrator weighing 20 pounds, and three personnel weighing 223, 210, and 193 pounds, respectively, for an actual applied load of ±646 pounds. Free hook rotation was assessed with the aircraft operating on the ground in the static mode during both cable extension and retrieval operations.

b. Ease of operation of the hoist hook was assessed by seven aircrewmember participants performing the tasks described in paragraph 2.4.3.1.

2.4.4 Results

2.4.4.1 Both the EMRH and the IMRH systems were operationally compatible in combination with the Stokes litter, the semirigid poleless litter, SKEDCO™ litter, forest penetrator, SARVIP, and associated patient loads during litter loading and unloading on the center right carousel pan of the six-litter configuration in the fly position.

2.4.4.2 Results of the hoist/carousel litter pan capability assessment are listed in Table 3. The combined litter loads for the 4-litter carousel configurations was an 8-litter carrying capability with the IMRH versus an 18-litter carrying capability with the EMRH. The combined litter load for the 6-litter carousel configuration was an 8-litter carrying capability with the IMRH versus a 21-litter carrying capability with the EMRH. If all the test configurations in Table 3 were combined, the litter holding capability of the EMRH would provide a 143.75 percent increase in litter carrying capability over the IMRH.

2.4.4.3 Operation of the EMRH and IMRH override systems were satisfactory. Both systems were functional and used identical controls. The positioning of control panels did not offer marked advantages or disadvantages to either system.

Table 3.

Possible carousel loads by hoist type.

Position	EMRH	IMRH
4 litter fly position only	TR, BR	TR, BR
4 litter 45° position only	TR, BR, TL, BL	TR, BR
4 litter 45° position then to fly position	TR, BR, TL, BL	TR, BR
4 litter load position	TR, BR, TL, BL	Load position N/A
4 litter load position then to fly position	TR, BR, TL, BL	TR, BR (load position N/A)
6 litter fly position	TR, MR, BR	TR, MR
6 litter 45° position	TR, MR, TL, ML	TR, MR
6 litter 45° position then to fly position	TR, MR, BR, TL, ML	TR, MR
6 litter load position	TR, MR, TL, ML	Load position N/A
6 litter load position then to fly position	TR, MR, BR, TL, ML	TR, MR (load position N/A)

Notes: TR = Top right pan MR = Middle right pan BR = Bottom right pan
TL = Top left pan ML = Middle left pan BL = Bottom left pan

1. Stokes litter with 95th percentile male mannequin in the horizontal lift position was the standard load.
2. No ambulatory patients were considered for load purposes.
3. Substantial "man handling" of the Stokes litter into position on the litter pans was considered acceptable to simulate a "worst case" scenario.
4. Only hoist assisted litter load maneuvering in the cabin area (tension on the hoist cable) was considered acceptable.
5. Movement of a loaded litter in the cabin area or on the litter pan without hoist cable security was considered not acceptable.

2.4.4.4 Operation of the pendant graduated speed control on both the EMRH and IMRH was satisfactory. The sensitivity of the EMRH pendant graduated speed control required an adjustment/learning period of several minutes by each participant. Both pendants were operated by crewmembers wearing four different glove configurations without performance decrement. A "cable jump" was noted in the EMRH system and is addressed in the Safety subtest paragraph 2.5.3.4.

2.4.4.5 The operation and procedural requirements for activation of the cable cutter mechanism of the EMRH and IMRH systems are similar. No adverse implications were noted. Location of the panel on the pilot's console varies between the two systems, but the positioning was considered to produce a negligible effect on performance.

2.4.4.6 The hydraulic temperature warning light and the 10 foot in/10 foot out lights on the IMRH pendant were seen easily during daylight operations with the exception of when the pendant was in direct sunlight. Crewmembers said, if necessary, it is a common and simple practice to shield the pendant from the sun and to check the lights. During night operations, the lights can be "dimmed" for adequate unaided vision. To prevent interference with NVGs during night operations, the red and yellow lights must be covered manually with tape prior to flight or covered with the hand during hoist operations (the least preferred method). The EMRH system evaluated did not include the hydraulic temperature warning light and did not have a 10-foot in/10 foot out light system on the pendant. Both lights previously have been recommended for pendant placement (paragraphs 2.2.4.8 and 2.2.4.10) and should be NVG blue/green compatible. The addition of the EMRH infrared (IR) fixed spotlight enhanced hoist life safety by allowing crewmembers to observe the litter load during the full 200-foot hoist test cycle. Operation of the IR search light does not diminish pilot or crewmember NVG capability in any manner. The overhead panel that contains the switches for the spotlight does not illuminate and is not directly or indirectly lit. Therefore, the spotlight operation (requiring manipulation of two switches) must be accomplished tactually after switch location and setting combinations are memorized.

2.4.4.7 Both the EMRH and IMRH hooks rotated freely under the specified loads in the static mode, during cable extension, and cable lift operations. Both the EMRH and the IMRH hooks were easy to operate. Hook latch operation with the pit pin keeper used on the IMRH hook was found to be satisfactory. The lack of a pit pin keeper on the EMRH hook will be discussed in the Safety subtest paragraph 2.5.3.4.

2.5 SAFETY

2.5.1 Objective

To determine any characteristics of the EMRH hoist system that may be detrimental to safety compared to the IMRH.

2.5.2 Criteria

2.5.2.1 Compare the EMRH to the IMRH safety provisions for the cable cutter switch.

2.5.2.2 Compare the EMRH to the IMRH for operational hand pinch hazards during hoist operations.

2.5.2.3 Compare the EMRH to the IMRH for warning placards/proper markings.

2.5.2.4 Compare the EMRH to the IMRH for possible operational safety hazards present to the hoist load (patient, litter, etc.).

2.5.2.5 Compare the EMRH to the IMRH for possible operational safety hazards present to the aircraft.

2.5.2.6 Assess the IMRH for communications and avionics compatibility with the aircraft.

2.5.3 Data acquisition procedure

2.5.3.1 More than the required five crewmembers evaluated the possibility and potential modes of pinch hazard present to the crewmember during the operation of both the EMRH and IMRH systems. Subjective comparative assessments revealed the IMRH hoist hook collar presents a pinch hazard to the operator when the operator is holding (guiding) the cable during the final lift stage of forest penetrator operations. The hand can be pinched between the hook collar and the base of the cable guide on the hoist arm. This condition does not exist with the EMRH due to the external overhead placement of the cable guide into the hoist pod assembly.

2.5.3.2 The USAARL aviation safety officer, in conjunction with the project officer, assessed the adequacy of safety warnings, placards, and markings on the EMRH and IMRH systems. The hand pinch hazard present on the IMRH is not labeled.

2.5.3.3 Project personnel and aircrewmembers evaluated potential safety hazards present to the hoist load (patient, litter, etc.) during both ground and flight test. These evaluations were in conjunction with both the EMRH and IMRH operations. The following is a detailed description of each safety assessment:

a. The safety latches on the EMRH primary hook and auxiliary hooks do not provide a safety pin or keeper to secure the spring loaded safety latch and prevent inadvertent release (Figure 11).

b. The auxiliary hook side of the EMRH hoist hook will allow hookup of two carabiners but the safety latch provided cannot close (Figure 19). Lateral forces or torque will allow the second carabiner and corresponding load of patient or equipment to rotate out of the hook and inadvertently be released (lost) during hoist operations. This is not likely during training, but future MEDEVAC hoist mission scenarios include over water rescues of multiple downed aircrewmember victims hooking up their own SARVIP to the hoist hook. By doctrine, Army medical crewmembers do not enter the water to assist victims as do Navy rescue teams. In the confusion and possible panic of such a scenario, the downed crewmember victims would be at risk with the present EMRH auxiliary hook design.

c. The EMRH pendant does not incorporate a "10 foot in/10 foot out" light on the pendant. Crewmembers said unintentional litter (patient) strikes on the bottom of the aircraft or on the wheel could be expected without this feature during night hoist operations. The light now incorporated on the IMRH pendant is not NVG compatible.

d. The SKEDCO™ litter used in this test was not designated as an item to be evaluated during this test, but a critical condition was experienced during the EMRH flight tests. The aircraft was hovering at approximately 100 feet AGL with the EMRH hoist cable extended to the ground and connected to the SKEDCO™ litter. The litter contained the 95th percentile male mannequin and was configured for a horizontal lift. The SKEDCO™ litter had been lifted through approximately 30 to 50 feet AGL when it began rotating, which quickly increased to a spin. The crewmember operating the pendant stopped the lift in an attempt to arrest the spin, but the spin kept increasing. Another attempt was made to stop the spin by lowering the litter, but the spin continued to increase. He stopped the descent a second time. By this time, the spin increased so rapidly the rectangular litter looked like a disc below the aircraft and an arc began to develop at the midpoint of the extended cable. The cable arc began to increase which brought the litter up vertically towards the aircraft. Through excellent crew coordination, the pilot at the controls immediately initiated a controlled accelerated descent which lowered the litter to the ground and arrested the spin. The crewmember operating the pendant later said he was within a second of activating the cable cut mechanism to prevent a possible hazard to flight. After a review of the hazard by the test officer and crew participants, it was decided to try another

hoist operation with a tether attached to the foot end of the SKEDCO™ litter. The tether was effective in preventing any spin during hoists up to the 250-feet cable limit. Although a climbing rope and three persons were initially used as ground support, forces incurred were minimal. One person was used for the remainder of the testing. The hazard experienced is not a reflection of the EMRH system. A near fatal accident was recorded in December 1989 by an Army MEDEVAC UH-1 with IMRH due to the same type spin with another flat surface litter called a Ferno basket litter. When the SKEDCO™ litter is configured for a horizontal lift, the flat solid plastic surfaces at the head and foot act as airfoils in the downwash of the helicopter's rotor system.

e. A "cable jump" was experienced during EMRH operations. This is a condition which occurs during initial activation of the thumb wheel on the pendant. When the thumb wheel was activated (up or down), the cable retracted in an instantaneous uncontrolled jerk of up to 6 inches. This condition was intermittent and was explained as a hydraulic servo valve null shift by the vendor. During our test the cable was always retracted, it never extended the cable. The vendor stated this problem was previously identified and narrowed to a specific lot number of faulty subcontractor components. The vendor further stated the hoist needed to be shipped back for replacement of the faulty component. [redacted]. The "cable jump" becomes critical when the aircrewmembers are maneuvering the hoisted litter in the cabin area. Small adjustments in cable length are necessary to help position the rescue litter on the appropriate litter pan. On several occasions, the cable jumped, and the head of the mannequin struck the overhead litter pan or the cabin ceiling. When the litter was hoisted from the ground, the litter was stopped below the wheel to stabilize the load prior to final loading (standard practice). When the pendant was activated again and the cable jump was experienced, the mannequin in the litter struck its head on the underside of landing gear. After the flight test was completed, the EMRH was sent to the vendor. After repair, the EMRH was reinstalled on the test aircraft. Subsequent hoist operations have been conducted without a repeat of the cable jump problem.

f. The IMRH system has no history of "cable jump," but has experienced an intermittent and uncontrolled "drop" or "slip" where the cable instantaneously extended or dropped 10 feet of cable. This condition has been documented by numerous MEDEVAC units and is of concern at present in the field. This condition was not experienced with the IMRH operations during this test.

2.5.3.4 Project personnel and aircrewmembers evaluated potential safety hazards present to the aircraft during both ground and

flight test. These evaluations were accomplished in conjunction with both the EMRH and IMRH operations.

a. There is a possibility of contact between the metal fold-down seat or the forest penetrator and the UH-60 ESSS 230-gallon tank (Figure 15) during both EMRH and IMRH operations. Further analysis must be accomplished on these tanks to determine the strength of the tank wall and possibility/probability/consequences of fuel tank damage by inadvertent contact with the forest penetrator seat during actual hoist operations.

b. The safetied switch guard (plastic cover) which protects the backup control power switch on the EMRH system is located overhead in the crew compartment on the backup control panel (Figure 19). During both ground and flight testing, test personnel accidentally contacted this cover with their flight helmets while moving about the cabin. Aircrews are sensitive to the vertical clearance of the cabin area and have learned how far they should bend down to clear the cabin roof while performing required aircrew duties, but they continually bumped this overhead cover.

c. During the loading and maneuvering of litter loads on the upper litter pans of the MEDEVAC carousel, the EMRH cable contacted and slightly abraded a 12½-inch section of the upper cabin door weather stripping and cabin roof (Figure 22). Damage was minimal due to the caution used by the test participants.

2.5.3.5 Communications and avionics compatibility were assessed by two qualified and current test pilots during ground run, hover, low-level flight, level flight at altitude during radio navigation, and during instrument landing system (ILS), visual omni range (VOR), and frequency modulation (FM) automatic direction finder (ADF) approaches. Communications assessments during all the above flight conditions at 5-hertz intervals through the entire range of FM, ultra high frequency (UHF), and very high frequency (VHF) communications systems onboard the test (UH-60) aircraft. During each step, the hoist was turned on and off both from the pilot's console and from the overhead console. The pendant also was activated in an up, then stop, followed by a down, then stop cycle. Communication between the hoist operator and the pilots commonly is restricted to visual hand signals during hoist operations. The cabin area "hot mike" is not used due to the rotary on/off switch and the location of this communication panel which is attached to the back of the pilot's seat and out of reach of the operator when he is positioned to operate the hoist. There is a "press to talk" switch located on the cabin floor, but it also is out of reach of the operator when he is operating the hoist. A "press to talk" switch, commonly

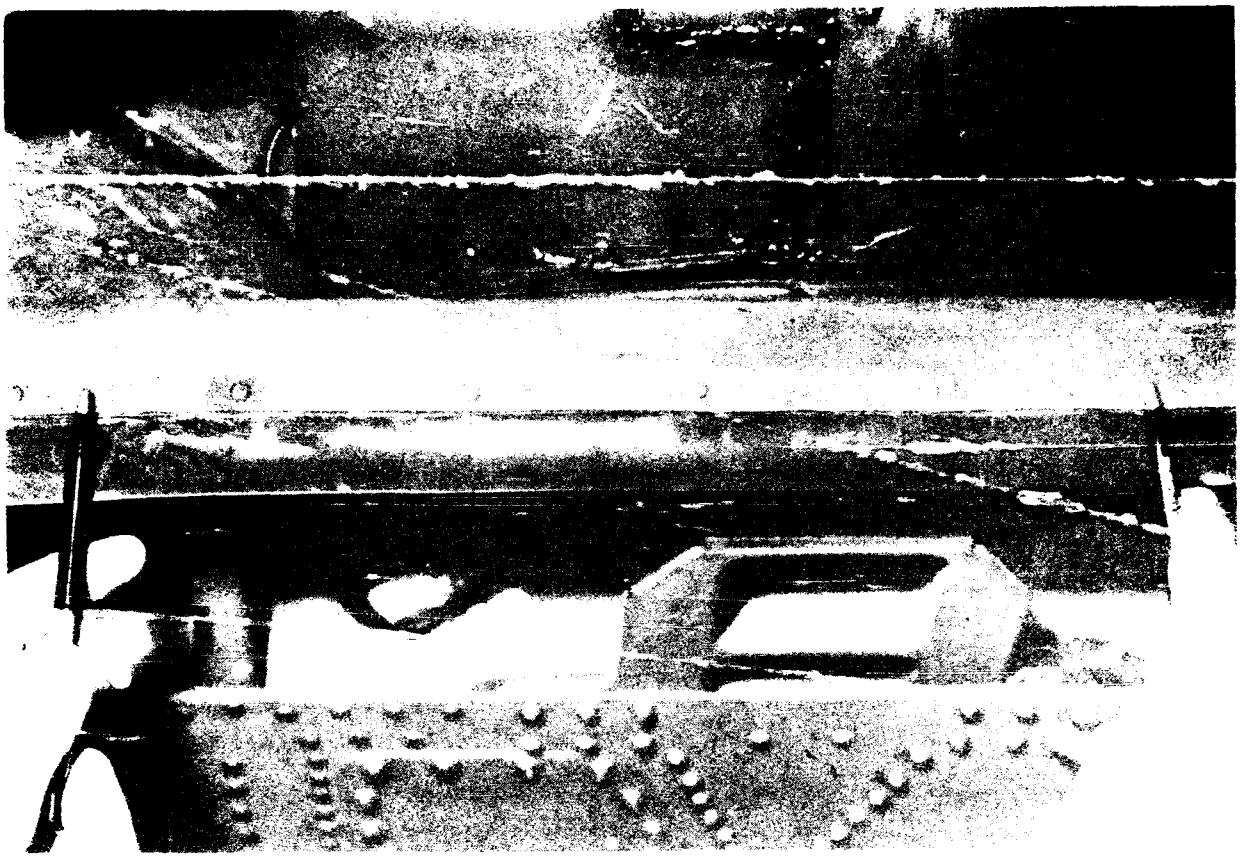

Figure 22. Abraded upper cabin door weather stripping.

2.5.3.6 Communications and avionics compatibility were assessed by two qualified and current test pilots during ground run, hover, low-level flight, level flight at altitude during radio navigation, and during instrument landing system (ILS), visual omni range (VOR), and frequency modulation (FM) automatic direction finder (ADF) approaches. Communications assessments during all the above flight conditions at 5-hertz intervals through the entire range of FM, ultra high frequency (UHF), and very high frequency (VHF) communications systems onboard the test (UH-60) aircraft. During each step, the hoist was turned on and off both from the pilot's console and from the overhead console. The pendant also was activated in an up, then stop, followed by a down, then stop cycle. Communication between the hoist operator and the pilots currently is restricted to visual [illegible] during hoist operations. The cabin area "hot mike" is not used due to the rotary dial switch and the location of the communication panel which is offset to the left of the pilot's seat and out of reach of the operator when he is [illegible]

2.5.4.1 IMRH operation presents a pinch hazard to the operator. The IMRH pinch hazard could result in a minor injury or lost workday accident. It has occurred in MEDEVAC units and aircrewmembers are aware of the hazard. It is given an RAC of IIIB. Proper training and a "Hand Pinch Hazard" placard on the IMRH would control this hazard. Operation of the EMRH system does not present a pinch hazard.

2.5.4.2 Safety warnings, placards, and markings on the EMRH system were found to be adequate. A "Hand Pinch Hazard" placard is needed on the IMRH.

2.5.4.3 Potential safety hazards to hoist loads are:

a. The lack of a safety pin or pit pin keeper on the EMRH hook safety latch could be catastrophic (cause death) to the lifted patient. Probably, it would occur several times during the life of the item in the MEDEVAC fleet. It is given an RAC of IC. Installation of a pit pin keeper would eliminate this hazard.

b. Under current and planned MEDEVAC mission scenarios, the operational auxiliary hook hazard could be catastrophic (cause death) and could occur frequently in the MEDEVAC fleet during over-water rescue scenarios. It is given an RAC of IB. Elimination of the auxiliary hook would eliminate this hazard. Training of all aircrews on over-water rescue and the danger associated with the auxiliary hook adequately would control this hazard.

c. The lack of a "10 foot in/10 foot out" warning light on the EMRH pendant could contribute to a permanent partial disability or temporary total disability in excess of 3 months and likely would occur several times within the life of the fielded EMRH system. It is given an RAC of IIB. The addition of a "10 foot in/10 foot out" warning light on the EMRH pendant would eliminate this hazard.

d. The following is an ancillary observation made during the flight test phase, and is present in both EMRH and IMRH operations: The SKEDCO™ litter used during flight test of the EMRH caused serious concern. The flat surface of the litter responded to the rotor wash of the aircraft and resulted in an uncontrollable spin. The spin can eject the patient if not adequately secured or cause blood pooling in the head and feet which could result in death. SKEDCO™ litter use without a tether may cause death and is likely to occur frequently within the life of the fielded SKEDCO™ or any flat surface type litter. Flat surface litters are given an RAC of IA. Use of a tag line or tether would control this hazard.

2.5.4.5 Potential hazards to the aircraft are:

a. Contact between the metal fold-down seat of the forest penetrator and the ESSS 230-gallon fuel tanks is certain within the life of the EMRH or IMRH. Hazard classification could be from IA to IVD as a function of the possibility of fuel tank damage in varying mission scenarios. Temporary corrective action would be a restriction prohibiting forest penetrator use during hoist operations until further analysis can be accomplished on the ESSS fuel tanks.

b. The safetied switch guard (plastic cover) which protects the backup control power switch on the EMRH system has been identified as a major annoyance by the aircrews and it will be subjected to constant breakage if fielded in its present state and location. Breakage of the cover could result in inadvertent activation of the backup power control. This condition would not cause damage to the airframe or crew, but would unnecessarily alert the crew to a false emergency situation and possibly diminish mission performance. The hazard can be eliminated by reducing the cover in all dimensions. The grasp lip could be extended horizontally from the base rather than from the side (Figures 23 and 24), and the cover would still adequately protect the toggle switch and a pressure activated switch.

c. The EMRH cable contacts and abrades the upper cabin door weather stripping and cabin roof. This condition will cause minor damage but will occur frequently during EMRH operations with use of the MEDEVAC carousel. It is given an RAC of IVA. This hazard can be controlled with a protective roller or bar installed along the cabin roof edge where the abrasion is experienced.

2.5.4.6 Communications and avionics compatibility were found to be adequate. However, hoist operators avoid intercom transmission to the pilots due to the noise involved during hoist operations and the difficulty in transmitting. This communication problem is tied to the cable cut hazard addressed in paragraph 2.5.3.1 and is given an RAC of ID in paragraph 2.5.4.1. The incorporation of a "press to talk" switch or hot mike toggle switch on the hoist pendant would allow immediate one finger access, provide acceptable communication for the hoist operator, and offer an acceptable solution to the cable cut hazard.

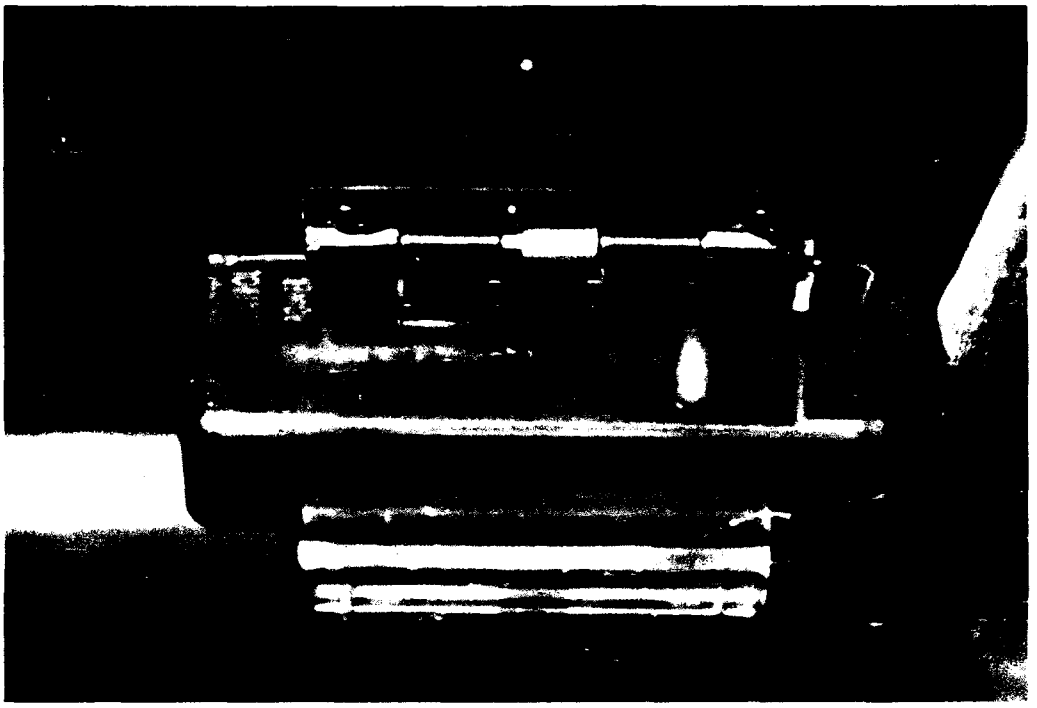

Figure 23. Backup control power switch guard (rear view).

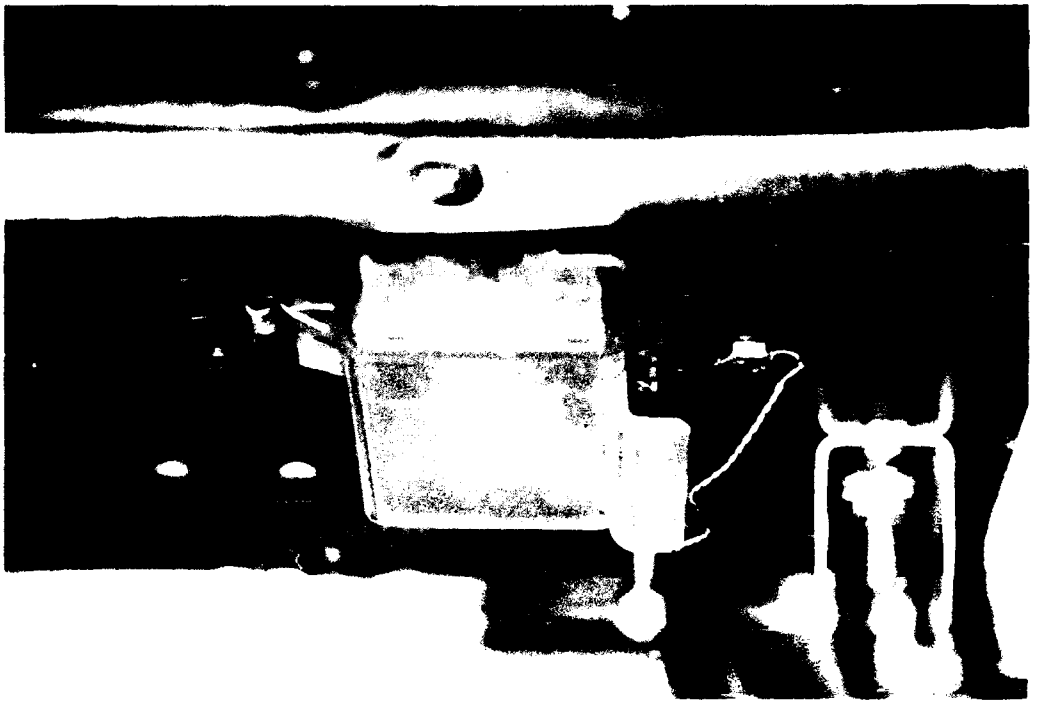

Figure 24. Backup control power switch guard (side view).

2.5.4.7 The operation of the EMRH system during loss of the UH-60 primary hydraulic system can interfere with flight performance. This condition can be catastropnic and could occur several times in the life of the EMRH system. It is given an RAC of IC. This hazard can be controlled by placing a "Warning" in the UH-60 operator's manual prohibiting hoist operation during a primary hydraulic system failure.

References

Department of Defense. 1987. System safety program requirements. Washington, DC: Department of Defense. MIL-STD-882B. July.

Department of the Army. 1982. The Army safety program. Washington, DC: Department of the Army. AR-385-10.

Department of the Army. 1978. Operator's manual, UH-60 and EH-60 helicopter, with changes 1-5. Washington, DC: Department of the Army. TM 55-1520-237-10. January.

Department of the Navy. 1985. Organizational maintenance principles of operation rescue hoist system, change 3. Washington, DC: Department of the Navy. A1-H60BB-490-100. November.

St. Cyr, Frank J., Maertens, Thomas B., Farrior, Rhett D., and Szczepanski, Richard D. 1978. Development test II (prototype qualification test-Government) of utility helicopter high performance hoist. Fort Rucker, AL: U.S. Army Aircraft Development Test Activity. TECOM Project No. 4-AI-177-01H-022.

Appendix A.

Tasking memorandums.

DEPARTMENT OF THE ARMY
US ARMY MEDICAL RESEARCH AND DEVELOPMENT COMMAND
FORT DETRICK, FREDERICK, MD 21701-5012

REPLY TO
ATTENTION OF:

SGRD-UMA (70-1r) 24 FEB 1988

MEMORANDUM FOR: Commander, U.S. Army Aeromedical Research Laboratory, Fort Rucker, AL 36362-5000

SUBJECT: Externally Mounted Rescue Hoist (EMRH), UH60

1. Request you perform the following actions to assess and evaluate the increased medical evacuation (MEDEVAC) capabilities of a UH60 MEDEVAC helicopter equipped with an externally mounted rescue hoist.

a. Obtain a cost proposal with Sikorsky Aircraft through Black Hawk PMO to structurally modify UH60 Black Hawk Helicopter to accommodate a pod mounted external rescue hoist.

b. Provide the UH60 to Sikorsky for this modification and fitting of an external hoist.

c. Coordinate with Navy Aviation Supply Office (ASO) on modifying contract N00383-88-C-8288 with Breeze-Eastern to acquire one externally mounted rescue hoist, Part Number BL-27100-89 which will be installed by Sikorsky. Purchase via a Purchase Request, one communication pendant and box.

d. Obtain from Black Hawk PMO, a MEDEVAC Mission Kit which will be used in the Concept Evaluation Program (CEP) of the UH60 to properly assess the form, fit, and function of an EMRH in a fully equipped MEDEVAC UH60.

2. Funding for the program will be provided to USAARL once the proposal has been reviewed by USAMMDA. Funding for the purchase and installation of a control pendant and box, and the Breeze-Eastern external hoist, as well as the UH60 roof modifications is not to exceed $275K.

3. Please keep RAD II, U.S. Army Medical Research and Development Command (USAMRDC) and U.S. Army Medical Materiel Development Activity (USAMMDA) informed on all future actions concerning the EMRH.

4. Point of contact for this action is 1LT Zajac, USAMMDA, AUTOVON 343-7418 or Commercial (301)663-7418.

P.K. Russell

PHILIP K. RUSSELL
Major General, MC
Commanding

DEPARTMENT OF THE ARMY
US ARMY MEDICAL MATERIEL DEVELOPMENT ACTIVITY
FORT DETRICK, FREDERICK, MARYLAND 21701-5009

REPLY TO
ATTENTION OF:

SGRD-UMA (70-1r) 26 April 1989

MEMORANDUM FOR Commander, U.S. Army Aeromedical Research Laboratory, ATTN: SGRD-UAD-IE (CW4 Woodrum), Fort Rucker, AL 36362-5292

SUBJECT: Side by side analysis of the UH-60A externally mounted rescue and internally mounted rescue hoist

1. Reference, 24 Feb 88, memorandum for Commander, U.S. Army Aeromedical Research Labortory (enclosed), tasking the organization to evaluate the concept of an externally mounted rescue hoist.

2. The purpose of this memo is to clarify the tasking in reference letter, item 1d.

3. The purpose of this analysis is to evaluate the concept of an externally mounted rescue hoist against the currently used internally mounted rescue hoist. The outcome of this analysis will provide data in order to reach recommendations concerning further development of the external hoist.

4. The test plan should incorporate test criteria which investigate:

a. The amount of usable interior space saved by mounting the rescue hoist externally verses internally.

b. Whether the space is compatible with the carousel 4 man and 6 man configuration.

c. If the externally mounted hoist is usable with the ESSS system installed.

d. Improvements or possible detractors to mission accomplishment in a side by side comparison of the internally verses externally mounted rescue hoist.

e. Issues of new equipment training requirements, installation and removal, reliability, maintainability, supply support, airframe electronic compatibility, human factors, and safety will be evaluated for information purposes only with no pass/fail criterion.

SGRD-UMA
SUBJECT: Side by side analysis of the UH-60A externally mounted rescue and internally mounted rescue hoist.

5. Point of Contact for this Activity is 1LT Andrew Zajac, AUTOVON 343-7418 or commercial (301) 663-7418.

6. USAMMDA - Developing Quality Medical Products for Soldiers.

Bernard A. Schiefer

Encl

BERNARD A. SCHIEFER
Colonel, MS
Project Manager
Applied Medical Systems

Appendix B.

Airworthiness release.

DEPARTMENT OF THE ARMY
HEADQUARTERS, US ARMY AVIATION SYSTEMS COMMAND
4300 GOODFELLOW BOULEVARD, ST. LOUIS, MO. 63120-1798

REPLY TO ATTENTION OF

26060 WIEHR

AMSAV-ECU

JAN 9 1989

MEMORANDUM FOR:

Commander, U.S. Army Aeromedical Research Laboratory, ATTN: SGRD-UAX, Fort Rucker, AL 36362-5292
Project Manager, BLACKHAWK, ATTN: AMCPM-BH, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798

SUBJECT: Airworthiness Release for UH-60A BLACKHAWK Helicopter 88-26069 with an Externally Mounted Rescue Hoist Installed

1. Reference:

a. Technical Manual 55-1520-237-10, UH-60A Operator's Manual, 8 Jan 88, through Change 1, 29 Mar 88.

b. Technical Manual A1-H60BB-WFM-000, SH-60B Operator's Manual.

c. Drawing Sikorsky 61076-20085, 70553-77001, 70080-65006, 70083-20034, 70083-20134, 70083-60002, 70083-85100, 70083-85102, 70080-20064, 70080-55224, 70080-30018, 70080-20065, 70209-22101, 70209-62001, 70080-85006, 70850-22113, and 70850-26211, Sikorsky Aircraft, Rescue Hoist Installation.

d. Report Sikrosky Aircraft, 31 Jul 79, subject: Structural Analysis of Prototype Rescue Hoist Structure.

e. DF, SGRD-UAV-AL, 20 Dec 88, subject: Request for Airworthiness Release.

2. This memorandum constitutes and Airworthiness Release in accordance with (IAW) AR 70-62 for the purpose of authorization to operate UH-60A S/N 88-26069 with an externally mounted rescue hoist installed.

3. The UH-60A helicopter is defined in reference 1a with exceptions as noted on the respective DD Form 250 acceptance document. The rescue hoist shall be installed IAW reference 1c and 1e.

4. The flight envelopes, operating instructions, and limitations for the UH-60A helicopter shall be IAW reference 1a Operator's Manual and this document. If there is a conflict between reference 1a manual and this Airworthiness Release this Airworthiness Release shall prevail. The rescue hoist shall be installed IAW reference 1c and 1e and shall be operated IAW reference 1b.

AMSAV-ECU JAN 9 1989

SUBJECT: Airworthiness Release for UH-60A BLACKHAWK Helicopter 88-26069 with an Externally Mounted Rescue Hoist Installed

CAUTION

This hoist is designed to hold 200 feet of cable. Care must be taken when winding the cable onto the drum.

5. The aircraft shall be inspected and maintained IAW all applicable Maintenance Manuals, Safety-of-Flight Messages, Maintenance Advisory Messages, and this Release. A daily visual inspection shall be made of the subject installation to insure that no progressive structural deterioration is occurring, that there is not loss of security, and that no damage to the host helicopter exists. Any occurrence of the preceding shall be corrected prior to further flight operations.

6. Aircraft Logbook Entries:

a. In accordance with the provisions of DA PAM 738-751, the following entries shall be made on DA Form 2408-13 and will be perpetuated on each form until the Airworthiness Release is terminated.

(1) Block 17 - Operate within the limitations prescribed in the enclosed Airworthiness Release dated JAN 9 1989

(2) The above entry will be proceeded by the entry of a circle red "X" within Block 16 and Block 7, adjusted when appropriate.

b. A copy of this Airworthiness Release shall be placed in the aircraft logbook.

7. This Airworthiness Release is terminated by changes in configuration or issuance of another Airworthiness Release.

FOR THE COMMANDER:

JAMES A. RAY
Acting Director of Engineering

MFR: This is the same hoist as the EUSA a/c. The ~~same~~ structure mods were done on the S. Korsky production lines. Kent Fugua

typist MT

ORIGINATOR	KF 12/22
TEAM LDR/SDE	WB
DIV CHIEF	
FILE	

3 2

Appendix C.

Weight and balance forms.

WEIGHT AND BALANCE FORM F — TRANSPORT

FOR USE WITH T.O. 1-1C-10 MAINTENANCE MANUAL 01-75-40, AND T.M. 55-405 9

08

DATE (YYMMDD)	OCT 25, 1989
AIRCRAFT TYPE	UH-60A
SERIAL NO	88-26069
FROM	
TO	
HOME STATION	FT. RUCKER, AL
PILOT	
MISSION	TEST

REMARKS

PILOT, COPILOT & TWO CREWMEMBERS.
800 LBS. FUEL ON T/OFF
MEDEVAC KIT & RESCUE HOIST INSTALLED.
300 LBS FUEL ON LANDING.

REF	ITEM	WEIGHT	INDEX OR MOM /1000
1	BASIC AIRCRAFT (From Chart C)	12500	4390
2	OTL (Gal.)	PART OF BASIC WEIGHT	
3	CREW (No.) 2	400	91
4	CREW'S BAGGAGE		
5	STEWARD'S EQUIPMENT		
6	EMERGENCY EQUIPMENT		
7	EXTRA EQUIPMENT		
8			
9	OPERATING WEIGHT	12450	4391
10	TAKEOFF FUEL (123.1 Gal.)	800	337
11	WATER INJ.		
12	TOTAL AIRCRAFT WEIGHT	13250	4728

LOAD ADJUSTER NUMBER: CHART "E"

CORRECTIONS/MOST FWD/MOST AFT

13 DISTRIBUTION OF ALLOWABLE LOAD (PAYLOAD)

ZERO FUEL WT 12950

ZERO FUEL WT INDEX OR MOM 4522

ZERO FUEL % MAC 351.9

COMPT OR ARM	ITEM	CHANGES (+ or -) WEIGHT	CHANGES (+ or -) INDEX OR MOM /1000	PASSENGERS NO.	PASSENGERS WEIGHT	COMPT OR ARM	CARGO	CARGO	COMPT OR ARM
				01	200		@ STA. 270.8		
				01	200		@ STA. 387.2		
	TOTAL WT REMOVED								
	TOTAL WT ADDED								
	NET DIFFERENCE								

CONDITION	TAKEOFF	LANDING	FUEL
ALLOWABLE GROSS WEIGHT	20250	20250	800
TOTAL AIRCRAFT WEIGHT (Ref 12)	13250		
(Ref 9) + (Ref 23)		12750	
OPERATING WEIGHT (Ref 9)			12450
ALLOWABLE LOAD (Ref 13) (use smallest figure)	7000	7500	
* Zero Fuel or Limiting Wing Fuel			
PERMISSIBLE C.G. TAKEOFF	FORWARD 342.6"	AFT 366.0"	
PERMISSIBLE C.G. LANDING	FORWARD 342.6"	AFT 366.3"	
PERMISSIBLE C.G. ZERO FUEL WT.	FORWARD 342.6"	AFT 365.1"	

COMPUTED BY (CIV) DYNCORP

WEIGHT AND BALANCE AUTHORITY SIGNATURE

PILOT SIGNATURE

14		
15		
16	TAKEOFF CONDITION (uncorrected)	13650 / 4859
17	TAKEOFF C.G. IN % M.A.C. OR IN	356.0"
18	CORRECTIONS (If required)	
19	TAKEOFF CONDITION (corrected)	13650 / 4859
20	TAKEOFF C.G. IN % M.A.C. OR IN	356.0"
21	ZERO FUEL WT	12850 / 4522
22	LESS AIR DROP LOAD	
23	ESTIMATED LANDING FUEL	300 / 126
24	ESTIMATED LANDING CONDITION	13150 / 4648
25	ESTIMATED LANDING C.G. IN % M.A.C. OR IN	353.5"

DD FORM 82 JAN 365-4 REPLACES DD FORM 365F, SEPT 84 WHICH WILL BE USED

WEIGHT AND BALANCE FORM F — TRANSPORT

FOR USE IN T.O. 1-1B-40, NAVAIR 01-1B-40, AND TM 55-405-9

DATE (YYMMDD) OCT 25, 1989	AIRCRAFT TYPE UH-60A	FROM	HOME STATION
08 MISSION TEST	SERIAL NO 88-26049	TO	PILOT FT. RUCKER, AL.

REMARKS

PILOT, COPILOT & TWO CREWMEMBERS.
FULL FUEL ON TAKEOFF.
MEDEVAC KIT & RESCUE HOIST INSTALLED.

LOAD ADJUSTER NUMBER CHART "E"

REF	ITEM	WEIGHT	INDEX OR MOM/ 1000
1	BASIC AIRCRAFT (From Chart C)	12050	4300
2	OIL (Gal.)	PART OF BASIC WEIGHT	
3	CREW (No. 2)	400	91
4	CREW'S BAGGAGE		
5	STEWARD'S EQUIPMENT		
6	EMERGENCY EQUIPMENT		
7	EXTRA EQUIPMENT		
8			
9	OPERATING WEIGHT	12450	4391
10	TAKEOFF FUEL (361.5 Gal.)	2350	989
11	WATER INJ.		
12	TOTAL AIRCRAFT WEIGHT	14800	5380

CORRECTIONS/MOST FWD/MOST AFT — 13 DISTRIBUTION OF ALLOWABLE LOAD (PAYLOAD)

ZERO FUEL WT 12850
ZERO FUEL WT INDEX OR MOM 4522
ZERO FUEL % MAC 351.9"

COMPT OR ARM	ITEM	CHANGES (+ or -) WEIGHT	INDEX OR MOM/1000	PASSENGERS NO.	PASSENGERS WEIGHT	COMPT OR ARM	CARGO	CARGO	COMPT OR ARM	WEIGHT	INDEX OR MOM
				01	200		@ STA. 270.8			200	54
				01	200		@ STA. 387.2			200	77
TOTAL WT REMOVED											
TOTAL WT ADDED											
NET DIFFERENCE											

LIMITATIONS

CONDITION	TAKEOFF	LANDING	FUEL
ALLOWABLE GROSS WEIGHT	20250	20250	2350
TOTAL AIRCRAFT WEIGHT (Ref. 12)	14800		
(Ref. 9) + (Ref. 23)		13038	
OPERATING WEIGHT (Ref. 9)			12450
ALLOWABLE LOAD (Ref. 13) (use smallest figure)	5450	7212	

Zero Fuel or Limiting Wing Fuel

	FORWARD	AFT
PERMISSIBLE C.G. TAKEOFF	344.6"	364.9"
PERMISSIBLE C.G. LANDING	342.6"	366.2"
PERMISSIBLE C.G. ZERO FUEL WT.	342.6"	365.1"

COMPUTED BY SIGNATURE (CIV) DYNCORP

WEIGHT AND BALANCE AUTHORITY SIGNATURE

PILOT SIGNATURE

REF	ITEM	WEIGHT	INDEX OR MOM
14			
15			
16	TAKEOFF CONDITION (uncorrected)	15200	5511
17	TAKEOFF C.G. IN % M.A.C. OR IN	362.6"	
18	CORRECTIONS (If required)		
19	TAKEOFF CONDITION (corrected)	15200	5511
20	TAKEOFF C.G. IN % M.A.C. OR IN	362.6"	
21	ZERO FUEL WT	12850	4522
22	LESS AIR DROP LOAD		
23	ESTIMATED LANDING FUEL	588	248
24	ESTIMATED LANDING CONDITION	13438	4770
25	ESTIMATED LANDING C.G. IN % M.A.C. OR IN	355.0"	

DD FORM 365-4, 62 JAN — REPLACES DD FORM 365F, SEP 54, WHICH WILL BE USED

WEIGHT AND BALANCE FORM F — TRANSPORT

FOR USE IN T.O. 1-1B-40, NAVAIR 01-1B-40, AND TM 55-405-9

08

DATE (YYMMDD)	AIRCRAFT TYPE	FROM	HOME STATION
OCT 25, 1989	UH-60A		FT. RUCKER, AL.
MISSION	**SERIAL NO.**	**TO**	**PILOT**
TEST	88-26069		

REMARKS

PILOT, COPILOT & TWO
CREWMEMBERS
800 LBS FUEL ON
TAKEOFF. 300 LBS FUEL
ON LANDING.
MEDEVAC KIT & RESCUE
HOIST INSTALLED.
THREE(3) LITTER PTS.,
2 LH & 1 RH.
600 LB. HOIST LOAD.

LOAD ADJUSTER NUMBER: CHART "E"

REF	ITEM	WEIGHT	INDEX OR MOM/1000
1	BASIC AIRCRAFT (From Chart C)	12050	4300
2	OIL (Gal.)	PART OF BASIC WEIGHT	
3	CREW (No.) 2	400	91
4	CREW'S BAGGAGE		
5	STEWARD'S EQUIPMENT		
6	EMERGENCY EQUIPMENT		
7	EXTRA EQUIPMENT		
8			
9	OPERATING WEIGHT	12450	4391
10	TAKEOFF FUEL (123.1 Gal.)	800	337
11	WATER INJ.		
12	TOTAL AIRCRAFT WEIGHT	13250	4728

CORRECTIONS/MOST FWD/MOST AFT

13 DISTRIBUTION OF ALLOWABLE LOAD (PAYLOAD)

ZERO FUEL WT: 14245
ZERO FUEL WT INDEX OR MOM: 4996
ZERO FUEL % MAC: 350.7"

COMPT OR ARM	ITEM	CHANGES (+ or -) WEIGHT	CHANGES (+ or -) INDEX OR MOM/1000	PASSENGERS NO.	PASSENGERS WEIGHT	COMPT OR ARM	CARGO	CARGO	COMPT OR ARM	WEIGHT	INDEX OR MOM/1000
				01	200		@ STA. 270.8			200	54
				01	200		@ STA. 387.2			200	77
							HOIST LOAD 600 LBS.			600	201
							LITTER PTS. 3 @ 265 EA.			795	273
	TOTAL WT REMOVED										
	TOTAL WT ADDED										
	NET DIFFERENCE										

LIMITATIONS

CONDITION	TAKEOFF	LANDING	FUEL
ALLOWABLE GROSS WEIGHT	20250	20250	800
TOTAL AIRCRAFT WEIGHT (Ref. 12)	13250	XXXX	XXXX
(Ref. 9) - (Ref. 23)	XXXX	12750	XXXX
OPERATING WEIGHT (Ref. 9)	XXXX	XXXX	12450
ALLOWABLE LOAD (Ref. 13) (use smallest figure)	7000	7500	

(Zero Fuel or Limiting Wing Fuel)

PERMISSIBLE C.G. TAKEOFF	FORWARD	344.4"	AFT	365.0"
PERMISSIBLE C.G. LANDING	FORWARD	343.7"	AFT	365.4"
PERMISSIBLE C.G. ZERO FUEL WT.	FORWARD	343.3"	AFT	365.6"

COMPUTED BY SIGNATURE: (CIV) DYNCORP

WEIGHT AND BALANCE AUTHORITY SIGNATURE

PILOT SIGNATURE

REF	ITEM	WEIGHT	INDEX OR MOM/1000
14			
15			
16	TAKEOFF CONDITION (uncorrected)	15045	5333
17	TAKEOFF C.G. IN % M.A.C. OR IN	354.5"	
18	CORRECTIONS (If required)		
19	TAKEOFF CONDITION (corrected)	15045	5333
20	TAKEOFF C.G. IN % M.A.C. OR IN	354.5"	
21	ZERO FUEL WT	14245	4996
22	LESS AIR DROP LOAD		
23	ESTIMATED LANDING FUEL	300	126
24	ESTIMATED LANDING CONDITION	14545	5122
25	ESTIMATED LANDING C.G. IN % M.A.C. OR IN	352.1"	

DD FORM 82 JAN 365-4 REPLACES DD FORM 365F, SEPT 54, WHICH WILL BE USED.

WEIGHT AND BALANCE FORM F — TRANSPORT

FOR USE IN T.O. 1-1B-40, NAVAIR 01-1B-40, AND TM 55-405-9

DATE (YYMMDD) OCT 25, 1989	AIRCRAFT TYPE UH-60A	FROM	HOME STATION FT. RUCKER, AL.
MISSION TEST	SERIAL NO. 88-26069	TO	PILOT

08

REMARKS

PILOT, COPILOT & TWO CREWMEMBERS.
800 LBS. FUEL ON TAKEOFF. 300 LBS FUEL ON LANDING.
MEDEVAC KIT & RESCUE HOIST INSTALLED.

600 LB. HOIST LOAD.

REF	ITEM	WEIGHT	INDEX OR MOM/1000
1	BASIC AIRCRAFT (From Chart C)	12050	4300
2	OIL / Gal.	PART OF BASIC WEIGHT	
3	CREW (No.) 2	400	91
4	CREW'S BAGGAGE		
5	STEWARD'S EQUIPMENT		
6	EMERGENCY EQUIPMENT		
7	EXTRA EQUIPMENT		
8			
9	OPERATING WEIGHT	12450	4391
10	TAKEOFF FUEL / 123.1 Gal.	800	337
11	WATER (If)		
12	TOTAL AIRCRAFT WEIGHT	13250	4728

LOAD ADJUSTER NUMBER CHART "F"

CORRECTIONS/MOST FWD/MOST AFT

13 DISTRIBUTION OF ALLOWABLE LOAD (PAYLOAD)

COMPT OR ARM	ITEM	CHANGES (+ or -) WEIGHT	CHANGES (+ or -) INDEX OR MOM/1000	PASSENGERS NO	PASSENGERS WEIGHT	COMPT OR ARM	CARGO	CARGO	COMPT OR ARM
				01	200		@ STA. 270.8		
				01	200		@ STA. 387.2		
					HOIST LOAD 600 LBS.				

ZERO FUEL WT	13450
ZERO FUEL WT INDEX OR MOM	4723
ZERO FUEL % MAC	351.2"

TOTAL WT REMOVED			
TOTAL WT ADDED			
NET DIFFERENCE			

LIMITATIONS

CONDITION	TAKEOFF	LANDING	FUEL
ALLOWABLE GROSS WEIGHT	20250	20250	800
TOTAL AIRCRAFT WEIGHT (Ref. 12)	13250		
(Ref. 9) - (Ref. 23)		12750	
OPERATING WEIGHT (Ref. 9)			12450
ALLOWABLE LOAD (Ref. 13 (use smallest figure))	7000	7500	
Zero Fuel or Limiting Wing Fuel			

PERMISSIBLE C G TAKEOFF	FORWARD 343.3"	AFT 365.6"
PERMISSIBLE C.G LANDING	FORWARD 342.7"	AFT 365.9"
PERMISSIBLE C G ZERO FUEL WT	FORWARD 342.6"	AFT 366.2"

COMPUTED BY SIGNATURE (CIV) DYNCORP

WEIGHT AND BALANCE AUTHORITY SIGNATURE

PILOT SIGNATURE

REF		WEIGHT	INDEX OR MOM/1000
14			
15			
16	TAKEOFF CONDITION (uncorrected)	14250	5060
17	TAKEOFF C.G. IN % M.A.C. OR IN	355.1"	
18	CORRECTIONS (If required)		
19	TAKEOFF CONDITION (corrected)	14250	5060
20	TAKEOFF C.G. IN % M.A.C. OR IN	355.1"	
21	ZERO FUEL WT	13450	4723
22	LESS AIR DROP LOAD		
23	ESTIMATED LANDING FUEL	300	126
24	ESTIMATED LANDING CONDITION	13750	4849
25	ESTIMATED LANDING C.G. IN % M.A.C. OR IN	352.7"	

DD FORM 82 JAN 365-4 REPLACES DD FORM 365F, SEPT 54, WHICH WILL BE USED

WEIGHT AND BALANCE FORM F — TRANSPORT

FOR USE IN T.O. 1 1B-40, NAVAIR 01-1B-40, AND TM-55-405-9

DATE (YYMMDD) OCT 25, 1989	AIRCRAFT TYPE UH-60A	FROM		HOME STATION FT. RUCKER, AL	
MISSION TEST	SERIAL NO 88-26049	TO		PILOT	

08

REMARKS

PILOT, COPILOT & TWO CREWMEMBERS.
800 LBS FUEL ON TAKEOFF. 300 LBS FUEL ON LANDING.
MEDEVAC KIT & RESCUE HOIST INSTALLED.

802 LB. HOIST LOAD.

REF	ITEM	WEIGHT	INDEX OR MOM/1000
1	BASIC AIRCRAFT (From Chart C)	12050	4300
2	OIL (Gal)	PART OF BASIC WEIGHT	
3	CREW (No.) 2	400	9.1
4	CREW'S BAGGAGE		
5	STEWARD'S EQUIPMENT		
6	EMERGENCY EQUIPMENT		
7	EXTRA EQUIPMENT		
8			
9	OPERATING WEIGHT	12450	4391
10	TAKEOFF FUEL (123.1 Gal.)	800	337
11	WATER INJ.		
12	TOTAL AIRCRAFT WEIGHT	13250	4728

LOAD ADJUSTER NUMBER CHART "E"

CORRECTIONS/MOST FWD/MOST AFT

ZERO FUEL WT 13652
ZERO FUEL WT INDEX OR MOM 4791
ZERO FUEL % MAC 350.9"

13 DISTRIBUTION OF ALLOWABLE LOAD (PAYLOAD)

COMPT OR ARM	ITEM	CHANGES (+ or -) WEIGHT	CHANGES (+ or -) INDEX OR MOM/1000	PASSENGERS NO.	PASSENGERS WEIGHT	COMPT OR ARM	CARGO	CARGO	COMPT OR ARM
				01	200		@ STA. 370.8		
				01	200		@ STA. 387.2		
					HOIST LOAD 802 LBS.				
TOTAL WT REMOVED									
TOTAL WT ADDED									
NET DIFFERENCE									

LIMITATIONS

CONDITION	TAKEOFF	LANDING	FUEL
ALLOWABLE GROSS WEIGHT	20250	20250	800
TOTAL AIRCRAFT WEIGHT (Ref. 13)	13250	XXXXX	XXXXX
(Ref. 9) - (Ref. 33)	XXXXX	12750	XXXXX
OPERATING WEIGHT (Ref. 9)	XXXXX	XXXXX	12450
ALLOWABLE LOAD (Ref. 13) (use smallest figure)	7000	7500	
*Zero Fuel or Limiting Wing *uel*			

PERMISSIBLE C.G TAKEOFF	FORWARD	343.6"	AFT	365.4"
PERMISSIBLE C.G LANDING	FORWARD	342.9"	AFT	365.8"
PERMISSIBLE C.G ZERO FUEL WT.	FORWARD	342.6"	AFT	366.0"

COMPUTED BY (SIGNATURE) (CIV) DYNCORP

WEIGHT AND BALANCE AUTHORITY SIGNATURE

PILOT SIGNATURE

REF	ITEM	WEIGHT	INDEX OR MOM/1000
14			
15			
16	TAKEOFF CONDITION (uncorrected)	14452	5128
17	TAKEOFF C.G. IN % M.A.C. OR IN	354.8"	
18	CORRECTIONS (If required)		
19	TAKEOFF CONDITION (corrected)	14452	5128
20	TAKEOFF C.G. IN % M.A.C. OR IN	354.8"	
21	ZERO FUEL WT	13652	4791
22	LESS AIR DROP LOAD		
23	ESTIMATED LANDING FUEL	300	126
24	ESTIMATED LANDING CONDITION	13952	4917
25	ESTIMATED LANDING C.G. IN % M.A.C. OR IN	352.4"	

DD FORM 82 JAN 365-4 REPLACES DD FORM 365F SEPT 84, WHICH WILL BE USED

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